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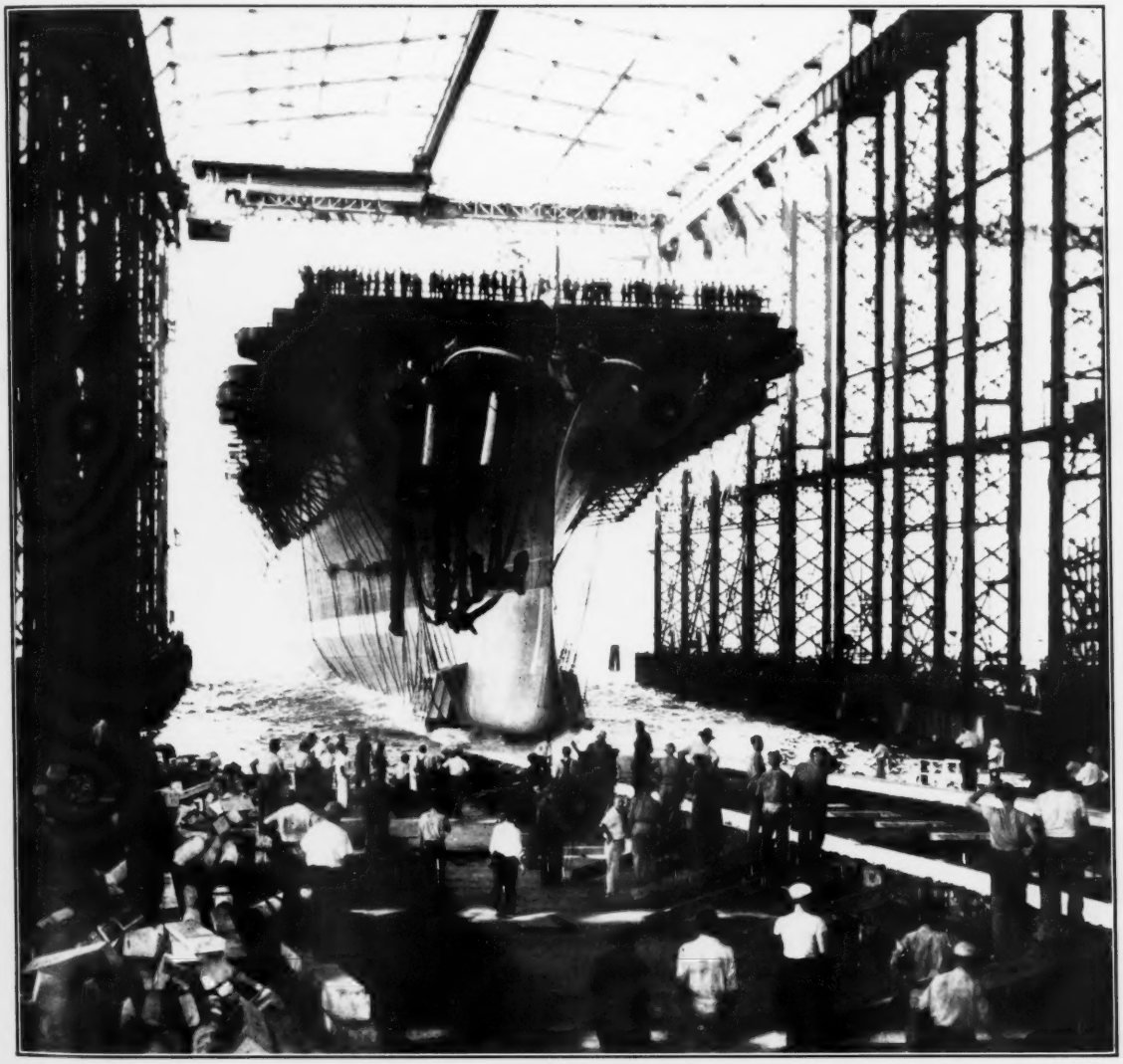

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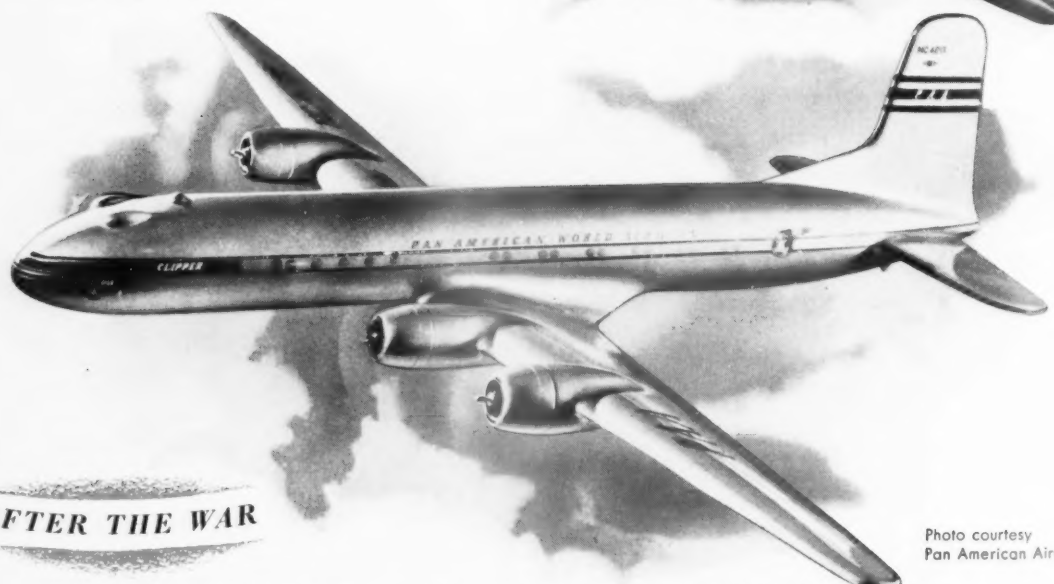

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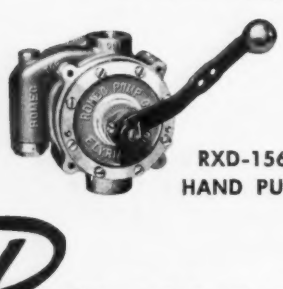

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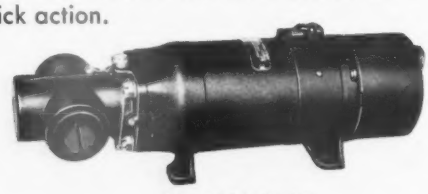

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CONTENTS

Cover Illustration

The launching of the aircraft carrier U.S.S. "Wright" by the New York Shipbuilding Corporation on September 1, 1945. The carrier was christened by Mrs. Harold S. Miller, niece of Wilbur Wright in whose honor the ship was named.

Articles

Research and the Army Air Forces . . . . **L. C. Craigie** 7

Fuel Quantity Measurement Problems . **A. J. Snyder** 13

The Air Position Indicator . . . . . **Arthur Wahl** 21

A General Method for Estimating Wing Weights . . . . . **John B. Scalzi** 27

Reviews

Periodicals 61

Government Publications 103

Books 115

Men Under Stress
Meteorology for Pilots
Principles and Practices of Inhalational Therapy

House Organs and Catalogues 129

From the Industry 139

General

Institute News 39

Personnel Opportunities 49

Source Material 121

Appreciation to Corporate Members 125

Index to Advertisers 153

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Research and the Army Air Forces

L. C. CRAIGIE*

Air Technical Service Command

Introduction

During the course of the war, production has held the number one priority. However, with the cessation of hostilities the emphasis is swinging back to research and development.

President Truman has announced a policy of adequate research and development to maintain our present supremacy in military aviation. This is most encouraging to all of us.

We are now revising our present program with the view of rounding it out—plugging up the holes. In view of the President's announced policy and, further, in view of the many expressions from Congress and others in high places, it is anticipated that the necessary funds will be provided. The amount of money required for such a program will not be high when compared to the costs of the war. It will be high when compared to prewar appropriations.

A vast amount of development has been carried on during the war. Only a fraction of that program was supported by funds directly provided the A.A.F. for research and development. A large portion of the load has been carried by the N.D.R.C., which has expended many millions each year on projects requested by the A.A.F. A large portion of the load has been carried by production contracts. The situation has not permitted us to develop an item completely and then put it in production. A great deal of actual development and most of the "debugging," which is merely another name for one branch of development, have been amortized over production contracts.

With the termination of the emergency the N.D.R.C. will soon terminate its work, and its personnel will go back to their original tasks in our educational institutions or industry or seek other employment. The large production contracts that have carried a considerable part of the development load are no longer with us. The result is that research and development must be prepared to stand on its own feet. These feet can only be provided through adequate appropriations and the provision of adequate personnel and facilities.

Development Costs

Attention must be directed to the problem of development costs—or rather, to the necessity of a program to get development costs under control. During the war we have been buying time. Speed of development was more important than economy in development. I do not anticipate any great difficulty in justifying to the various postwar investigating agencies excessive development costs where it can be shown that we were buying time in an effort to save American lives. A reference to the atomic bomb development should constitute an answer to most such queries. It cost a lot to develop in the relatively short time spent on its development, but it was money well spent.

During the postwar period it will not be easy to justify this particular type of expedited development. It is anticipated that Congress will provide adequate funds, but it is a certainty that they will not write us a blank check. So we, industry and the A.A.F., have got to learn once again that champagne, although a delectable drink, is not the only liquid that will quench thirst. We must realize that beer, too, has its place in the scheme of things.

In spite of my optimistic statement regarding Congress providing adequate funds, we should not plan on them being unlimited. They can only be spread so thinly. Therefore the extent to which we can cover the field of development will depend to a considerable extent on industry's ability to get costs under control.

Prewar Research

The United States today has become the most formidable air power on earth, but it did not rise to this position by mere chance. In the days of the "Blitz," Germany had the advantage of a developed and powerful air force. Fortunately for us, we were not then in direct conflict with the enemy. Our national economic structure had not as yet been converted for a war effort. Nevertheless, we had begun the ground work in the fields of research and development which has led us to our present strength. The technological battle was already under way. The physical battles that were to come depended for their outcome on how well the battles of the drafting boards, the test stands, and the wind tunnels were fought.

At the time of the sneak attack on Pearl Harbor, we were not caught napping from a research point of view. We had long before designed, and to some extent had developed, the airplanes that were destined to win the strategic air battle of Europe. This was our research reserve that had been built up in the peacetime years. A reserve that, when fed into the channels of production, brought us victory in Europe.

The step from original design to combat aircraft was not taken in a day or even in a year. It requires from 3 to 5 years to progress through the early development stages and emerge with an aircraft ready for its battle test. It is because of this time factor that our research minds must always be probing far in advance of our progress. The goal must be constantly advanced—pushed always beyond reach of our current capabilities. We must aggressively advance our scientific thought, lest others get out in front and we find ourselves lacking technological preparedness.

Wright Field

Recognition by the U.S. Army of the necessity of preparedness in the field of aeronautical science brought about the early establishment of a research center at Dayton, Ohio, familiarly known as Wright Field. It has been a function of "Wright Field" to administer the Army Air Forces program of research and development.

This program is carried out through cooperation between Government and American industry. The two work together, hand-in-glove, each having a separate function but at the same time working in unison, the work of one complementing the work of the other.

Primarily, there are three functions to be performed under this program: first, the function of pure research, wherein basic principles are determined, as exemplified by the work of agencies such as the National Advisory Committee for Aeronautics and, during the emergency, N.D.R.C., Cal. Tech, and M.I.T.; second, the function of development wherein those principles are applied by private industry to the problem in hand—in other words, engineering in the true sense; and third, the function of specification and evaluation. Naturally, there is some overlapping of these functions, but basically those are the three divisions through which the plan operates.

The Engineering Division

The integration and coordination of all three phases is the function of the Engineering Division of the Air Technical Service Command.

Within the Engineering Division are twelve individual laboratories working on the design, development, and test of aircraft and aircraft equipment. These laboratories are divided functionally between three subdivisions—namely, Aircraft and Physical Requirements, Propulsion and Accessories, and Radio and Radar. In these laboratories every piece of Air Forces equipment is tested and tested again. Here the products of

Presented at the Los Angeles Meeting, I.A.S., August 16–17, 1945.

* Brigadier General. Chief Engineering Division, Wright Field.

TWO MAJOR WAR DEVELOPMENTS

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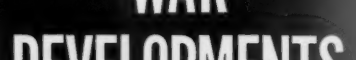
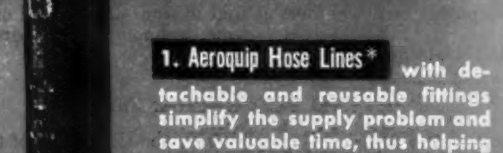


3 PIECES (each replaceable)

Assembly without special tools. No tightening or adjustment after assembly. Fittings can be removed from hose and reused over 100 times.



2. Aeroquip Self Sealing Couplings* allow disconnection of liquid carrying lines without loss of fluid and reconnection without inclusion of air.

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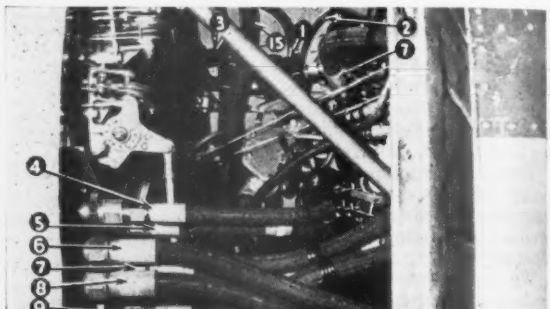
PCA CHANGES POWER PLANT INSTALLATION

Important economies and many operating advantages have been achieved by Penn-Central Airlines in changing to flexible hose lines instead of rigid plumbing in power plant installations.



1. Oil Vent.
2. Fuel Pressure Gauge.
3. Oil Line Return (Temp. Reg. to Tank).
4. Hydraulic Suction.
5. Hydraulic Pressure.
6. Vacuum Suction.
7. Fuel Supply.
8. Vacuum Pump Pressure.
9. Fuel Cross-Feed.
10. Oil Line (Temp. Reg. to Cooler).
11. Oil Pressure Gauge.
12. Manifold Pressure Gauge.
13. Carburetor Vent.
14. Fuel Pressure Gauge
15. Oil Line (Cooler to Tank).

"We are able to show a definite dollar and cents advantage for these changes," stated a PCA engineering official. Aeroquip lines and fittings have been chosen because for many years they have proven their efficiency on such installations as brakes, landing gear retracting mechanisms and flap actuating cylinders. The illustration shows a typical installation made on PCA's DC-3 airplanes. As an example of savings effected, one item, the prop-feathering line, shows a unit cost reduction of 72% by changing to Aeroquip.

In addition to cost benefits, users have the further advantage of working with fittings that are reusable on Aeroquip hose, which can be "tailored on the job" from bulk stocks, with resultant simplification of inventory and elimination of maintenance delays.

Fire-resistant qualities of this hose contribute a **safety factor** of recognized importance. Aeroquip hose lines with detachable, reusable fittings, and self-sealing couplings are standard equipment on military aircraft and carry **CAA approval.**

Engineering circles are evincing a wide interest in enlarged possibilities for uses, as demonstrated by these power plant applications and numerous airlines are changing to Aeroquip installations.

industry are matched against the most exacting specifications. Whenever an air frame, an engine, or a piece of equipment accomplishes a required test without difficulty, it is then decided that it is not rated high enough and up go the standards.

Wright Field is always endeavoring to improve its test equipment and procedures. The more accurately a product can be tested, the more efficient will be our production methods. The forging of supercharger turbine wheels, for example, was a grave problem before the development of supersonic test equipment. This new test procedure exposed flaws hitherto undetected and brought about an improved forging technique and, at the same time, assured the Air Forces that the accepted articles would withstand the strain of service. Production, in turn, was speeded up.

The Engineering Division is constantly searching for new and better methods and materials; it is looking for new applications of both. To this end we want a group of dissatisfied engineers. Nothing can be accepted as the ultimate; nothing can be assumed to be completely satisfactory. First, we find a material capable of performing a certain function; then we go about finding a better material, a cheaper material, or a new way of doing the job.

Each one of the laboratories naturally favors its own projects. The Aircraft Laboratory wants the airplane to have the perfect aerodynamic shape with nothing to break up the symmetry of the airflow. At the same time, the Power Plant Laboratory wants the emphasis placed on the engines; the Aircraft Radio Laboratory wants the plane to carry a full complement of antennae to operate with the communication and radio navigation equipment; and the Armament Laboratory would like the airplane to fairly bristle with cannon, etc. Obviously, bristling cannon, dozens of antennae, huge engines, all are incompatible with the perfect aerodynamic shape. The problem becomes one of balancing desirability against expediency.

Every engineering design is a compromise between the ideal and the practical, and compromises between the conflicting desires of the several laboratories are effected by the Aircraft Projects Section. This section must weigh the advantages of a particular item of equipment against the possible disadvantages that its addition to the aircraft may entail. For example, in the case of a long-range bomber, the addition of 1 lb. of equipment requires also the addition of 1 lb. of structure plus 1 lb. of fuel if range is to be maintained, or, in reality, the addition of 3 lbs. to the flying load of the aircraft. Should a 1-lb. accessory be added to an engine of a six-engined bomber, the total weight increase would be 18 lbs. Imagine what this would mean should the item weigh 100 lbs.—nearly a ton of extra load. To prevent a project from snowballing into gigantic proportions, a careful check is kept of weight additions, measured down to the ounce.

The Aircraft Projects Section is the coordinating agency for development projects, following through from the time a project is initiated until such time as further development is deemed unnecessary. This Section must ensure that the development program is consistent with the capabilities of the industry and that the industry's experimental facilities are used to maximum benefit. It is the further responsibility of this Section to examine the programs of the Navy and other services to eliminate duplication of effort wherever possible.

German Research Developments

To obtain a true picture of our research status, it is necessary to evaluate the program of our enemies. Much pertinent information is now available to us since the downfall of Germany. Material collected from the German scientific centers gives us a view of German accomplishments up to the close of the European War and a glimpse into the long-term scientific planning intended to become effective later.

An examination of these data shows that the Germans were not scientific supermen. They did not produce any miracles, but they did show what could be done by applied engineering effort in developing weapons of warfare. They demonstrated that engineers plus funds plus time can accomplish almost any desired result.

Serious German research on military aeronautics was begun in 1934, and it was not until 5 years had elapsed that the German leaders were ready to plunge into war. Not until the German Command believed that they had scientifically outstripped their opponents did they take the fateful step. It was at this point that Germany underestimated our research reserve. It was anticipated that a decision would be forced long before we could be prepared.

It is now history that American production overwhelmed the German Nation with aircraft designed during the peacetime years.

Rocket Research

Let us glance for a moment at some of the German developments and at some of their projected plans for the future. In 1936 the large rocket and research establishment was started at Peenemunde. It was divided into two separate establishments. One was operated by Ordnance for the development and testing of rocket projectiles and wingless missiles. The other was operated by the Air Force and was for the development of winged missiles and rocket-propelled aircraft. This latter section also included a flight-test base for testing jet aircraft and winged missiles.

One of the chief developments of Peenemunde was the A-4 Rocket, more widely known as the V-2. The first launching of the A-4 was in October, 1942. This early rocket had a thrust of 25 tons for 68 sec., and the range was a little greater than 150 miles. Mass production was ordered toward the end of 1942, and later improvements increased the range to approximately 300 miles.

An improved but uncompleted development of the A-4 was the A-9, which was basically the same rocket with the addition of highly sweptback wings to make it a stratosphere glider. This was estimated to increase the range by about 100 miles. The Germans also planned to develop a crew-carrying version of the A-9. This was to be provided with a pressure cabin and retractable landing gear or skid. It was estimated that an A-9 would cover 375 miles in 17 min. and would land at a speed of approximately 100 m.p.h.

A further development project that was not completed was a large assisted take-off rocket unit called the A-10. It was planned to combine the A-9 and A-10 to have a two-step rocket for long-range application. In initial operation the A-10 would function as a large tail fastened to the A-9. The start would be vertically upward and the A-10 would furnish a thrust of 200 tons. This would give the A-9 an estimated initial velocity in the neighborhood of 9,000 ft. per sec. (6,000 m.p.h.). After completion of initial combustion, the A-10 would automatically disconnect from the A-9 and the rocket motor of the A-9 would then start operation. The winged rocket would then assume a more horizontal attitude, and, since the air resistance would be negligible and the initial velocity high, a considerable range could be obtained. After completion of combustion in the A-9, it was still capable of traversing a long distance, which would still further be increased by the presence of wings. In this way it was estimated that the total range would be about 3,000 miles, and therefore the rocket could be used for crossing the Atlantic either as the V-2 type with war head or as a man-carrying version.

German reports indicate that some thoughts were given to the future possibilities of rockets. These were visionary and apparently only in the idea stage. The A-9 and A-10 principles could perhaps be extended, making possible a long-range transport or bomber capable of making the trip from Europe to America in about 40 min.

Another thought represented a further extension of the A-9 and A-10 step rocket principle by the addition of more steps so that the rocket could reach a final speed of about 5 miles per sec. (1,800 m.p.h.) outside the earth's atmosphere. Under these conditions the centrifugal force would balance that of gravity, and the rocket would then circulate around the earth indefinitely without further need for power.

From here on, further visualization can be as fanciful as you wish. You do not have to be a follower of Buck Rogers or Brick Bradford—but it helps. Observation platforms suspended in space—rocket shuttle service between the earth and these platforms—space suits—weather control through the medium of mirrors that would concentrate the sun's rays where desired. There is no indication that any of these ideas

Welded Exhaust Pipe for Thunderbirds

Stainless steel is essential in aircraft exhaust assemblies because it resists the corrosion of hot exhaust gases. With thousands of these assemblies being fabricated each month, the ease with which this metal can be welded is an important factor in maintaining production.

Because of their corrosion resistance and strength, stainless steel aircraft parts can be made of relatively thin gauge metal. These properties will be valuable for many other industrial applications when the easing of wartime restrictions again permits the wider use of stainless steel.

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Other interesting uses of stainless steel are described in ELECTROMET REVIEW published by ELECTRO METALLURGICAL COMPANY, the Unit of UNION CARBIDE and CARBON CORPORATION that produces alloys for making steel. If you are an executive, engineer, or designer you can be put on the mailing list for ELECTROMET REVIEW by sending your name on your business letterhead to ELECTRO METALLURGICAL COMPANY, Room 328, 30 East 42nd Street, New York 17, N. Y.

were carried beyond the speculation stage.

Jet Developments

German jet developments got an early start. Experimentation by industry began about 1936, and in 1938 a War Ministry Order provided government backing for jet research. By 1939 the Heinkel Company had an experimental model, the He 178, in the air, and intensive development was begun on military applications. Progress was retarded when the German Command transferred emphasis from research to production. But after our fighter-escorted bombers began to dominate the skies over Germany, development was hastily resumed and by the spring of 1944 occasional encounters with jet fighters were reported by our returning pilots.

Wind-Tunnel Projects

The Germans thought highly of the future of rocket and jet power and had begun to prepare extensive facilities for research and development in these fields. The research establishment at Peenemunde represented an investment of roughly $120,000,000. But this was only one of several extensive installations either in operation or in construction within the Reich. A large research center was under construction at Otztal near the junction of the Inn and the Otz rivers in the Austrian Tyrol, about 22 miles west of Innsbruck. Two 100,000-hp. wind tunnels were contemplated. The first of these was scheduled for operation in 1945 and was 80 per cent completed at the time the American troops took over. The tunnel has a throat of approximately 26 ft. and is designed to reach the speed of sound. The power is furnished by two Pelton water turbines delivering 50,000 hp. each, directly connected to counterrotating fans. The tunnel was intended to make high-speed aerodynamic tests on complete aircraft models, on full-scale component parts of aircraft, and on full-scale nacelles with operating propulsion systems. There was also planned a 36,000-hp. laboratory for the testing of compressors, turbines, combustion chambers, etc. The overall value of this research center would correspond to about $60,000,000 to $75,000,000 in United States money.

Another tunnel scheduled for operation during 1945 and more than 80 per cent completed at the cessation of hostilities was the altitude wind tunnel at Göttingen. It was made of heavy concrete construction, could be evacuated one-tenth of an atmosphere, and could be refrigerated to −64°C. A unique feature of this tunnel was the use of a large Flettner rotor at each corner instead of the usual corner vanes. This was to prevent icing difficulty at the corners. This tunnel was designed to conduct altitude tests on nacelles with operating propulsion systems, especially of the gas-turbine type. In addition, the tunnel was to be capable of making icing tests.

At Kochel in southern Germany, a 76,000-hp. supersonic wind tunnel was under construction. The purpose of this tunnel was the development of long-range winged missiles, capable of crossing the ocean. Construction was started in 1943 and was estimated for completion in the fall of 1945. About 25,000,000 marks, or, roughly $10,000,000, had been set up for this project, of which about $6,000,000 had been obligated.

These highlights of German installations show that their program was extensive and apparently generously supported by funds. However, the United States can tear a page from the German book of experience and use it as a warning lest we forget that research can only rarely be hurried, that it must be continuous, and that most of it must be accomplished during the years of peace. Research requires time and the Germans discovered that time was running out too quickly and that they did not have a sufficient backlog of research to carry them through. Feverish activity in the last 2 years could not turn the tide. The government attempted to accomplish new research and development by directive—simply ordering that such and such be done.

An example of the failure of this method was the attempt to stop our air fleets with rocket antiaircraft missiles. Time simply did not permit the accuracy of these missiles to be developed to the point of effectiveness.

Because of the cutback in research which took place in Germany about 1939, when every effort was expended on production, the development of materials failed to keep pace with later requirements. When the fortunes of war began to turn against the Germans, an effort was made to bring about the sudden development of new and decisive weapons, but they could not be produced by threats or by force. The years of systematic study necessary to provide the ground work had been neglected, and there was no longer time to catch up.

The policy of slave labor definitely backfired, reducing the quality and efficiency of the German product. Aside from work stoppages due to sabotage and the physical breakdown of the workers, production was impaired because the level of skill was too low to handle intricate devices. Inferior materials plus poor labor equals reduced efficiency. The efforts of good research were therefore lost.

Freeman Field

To facilitate the collection, evaluation, and dissemination of the aeronautical knowledge gained by our success in the European Theater of Operations, the Air Technical Service Command has established an evaluation center at Freeman Field, Ind. It is the intention that at least one sample of every piece of foreign aeronautical equipment from the European Theater will be examined, evaluated, and placed on display. Foreign aircraft either will be conditioned for flight tests or will be dissected for minute examination. Freeman Field will be open to the engineers from industry, as well as to those of the Air Forces, for purposes of study and comparison of foreign equipment with American products.

To ensure a complete and continuous flow of foreign technical information into this country, facilities have been established overseas for the collection and screening of all documents and publications pertaining to aeronautics and related subjects. The material will be forwarded to the United States for study and for possible use by both the Army Air Forces and the American aviation industry. That part of the material received at Wright Field will be cataloged by a staff of librarians and translators. A brief abstract in English will be prepared on each subject, and a periodic list will be circulated to Army Air Force contractors desiring to make a study of these documents. Loans will be made on request. Complete translations will not be available immediately because of the huge volume of material, but it is intended that translations of the important works will be prepared as rapidly as possible.

With these two collections, aircraft and associated equipment at Freeman Field and reference material received by the Army Air Forces from overseas, we will be able to provide American aviation with a wealth of valuable knowledge gained by our victory in Europe.

Future Development

The last 5 years have focused American scientific thought on aeronautical advancement. Progress has been accelerated by wartime spending. This singleness of purpose has built up a research momentum that is rapidly carrying us to the threshold of new discoveries with incalculable possibilities. We are penetrating the "compressibility wall." We are getting eyes with which to see in the dark and through the grayness of fog and cloud. We can envision the possibilities of atomic energy now that we can release it. The outlook ahead is unlimited. An aggressive research and development program must be continued so that we may harvest the fruits of our efforts and provide our nation with the scientific preparedness with which to face the future.

The long-awaited arrival of peace will be accompanied by a diversion of a large part of our scientific thinking into peacetime channels. It will be the responsibility, however, of American scientists and engineers, both in Government service and in industry, to provide a tremendous research reserve that will be readily available should we be brought into another conflict.

Before World War II our geographic location gave us a sense of security behind the bulwarks of two great oceans. It would be sheer folly, today, to settle back into a reliance on the barriers of mere distance for protection. In the light of scientific advancement, the Pearl Harbor of the future may well be the Main Street of any city in the United States. So fantastic may be the speed of the missiles of the next war

(Continued on page 37)

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Fuel Quantity Measurement Problems

A. J. SNYDER*

American Airlines, Inc.

Introduction

The tremendous fuel load of airplanes being considered for transoceanic and intercontinental flying has made the problem of accurate fuel quantity measurements more important than ever before. In air-line operation of medium size airplanes having a fuel load of 800–900 gal., a fuel quantity indication of ±5–6 per cent can be tolerated in making short-range calculations. However, considering an airplane requiring a fuel load of 3,000 gal. or more, a 5–6 per cent error in fuel measurements makes up a good portion of the useful load of the airplane and makes accurate long-range calculations difficult.

The passenger safety item, of course, is of utmost importance to the commercial operator. With the present inaccuracies in fuel measuring devices, a considerable quantity of reserve fuel must be carried as a safety measure, and therefore a sizable share of the operator profit must be sacrificed.

Fuel Measuring Systems

At the present time there are only two basic systems of fuel quantity measuring devices available and in use. One system, the float or liquid level type, utilizes the measurement of the fuel level from a given datum. The other type, the hydrostatic system, utilizes the pressure exerted by a known level or head of fuel.

The Liquid Level System

The equipment required to indicate full quantity by the liquid level method consists of a tank unit and an indicator. The tank unit consists of a cork or airtight chamber attached to a movable arm or shaft. The tank unit is inserted into the fuel cell so that the float rides on the surface of the fuel. The vertical motion of the float is transmitted by suitable linkages to the transmitter head, where it positions a transmitter unit of a remote electrical positioning device. Fig. 1 shows a typical tank unit installation.

In airplanes where integral wing tanks are used, it is necessary to use two or more tank units in each fuel cell. The dihedral of the wing makes it impossible for one float unit to cover the whole range of fuel levels. One float unit indicates the fuel quantity up to the point where it strikes the top of the fuel cell. At this point another float unit must take over the indications. The first float unit is disconnected from the electrical circuit by means of a switching device in the tank unit head.

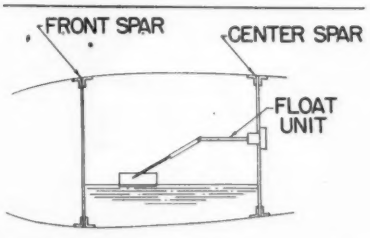

Fig. 1. Float-type fuel level transmitter.

The disadvantage in the use of multiple floats is that in rough air the splashing of the fuel in the region of the tank unit transfer points causes the indication pointer to oscillate. In actual practice the transfer switches must be adjusted so that appreciable float movement will not cause pointer oscillation. The fuel quantity indications are, therefore, extremely erratic at the transfer points.

The installation of tank units in the wing spar is unsatisfactory from the maintenance standpoint. In order to replace a tank unit, it is necessary to drain the tank and remove the necessary stress plates. This operation could very well put the airplane out of service for several hours.

The Hydrostatic System

The hydrostatic fuel quantity indicating system consists of a transmitter, an indicator, check valve, sump, shutoff valve, and a restrictor. Fig. 2 shows a typical installation on an airplane having integral wing tanks.

The transmitter is usually mounted underneath the fuel tank. It consists of a suitable electrical remote indicating device coupled to a measuring mechanism. The measuring device consists of a diaphragm installed in a liquid-tight chamber. The pressure head of the fuel is introduced directly into the chamber and acts on the outside of the diaphragm. The air pressure existing in the fuel cell above the fuel level is introduced into the inside of the diaphragm. The unit, therefore, acts as a simple differential pressure gage. The movement to the diaphragm is amplified and transmitted to the electrical position transmitting device by means of gears and levers.

The instrument is extremely sensitive, for a differential pressure of 1 lb. per sq.in. may very well cover the fuel level range of a 500-gal. capacity fuel tank. It can be readily seen that atmospheric pressure changes due to change in flight altitude would introduce serious errors into the system. For this reason it is necessary to keep the vent line clean at all times. A check valve installed in the vent line serves to prevent fuel from entering the vent line during changes in flight attitude. A sump or chamber must be installed at the lowest point in the vent line to prevent accumulation of moisture due to condensation.

Because of the extreme sensitivity of the instrument, it is essential to dampen pressure surges caused by splashing or shifting of fuel during bumpy weather. The restriction supplies the necessary

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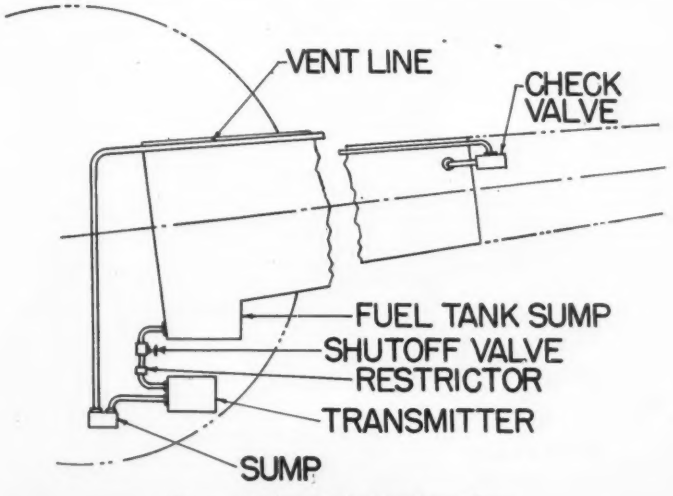

Fig. 2. Hydrostatic fuel level transmitter.

Presented at the National Fall Meeting, I.A.S., Dayton, Ohio, November 9–10, 1944.

* Assistant Project Engineer.

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(*Continued from page 15*)

dampening. This restriction may be installed in the pressure line itself or be incorporated in the transmitter unit itself.

A shut-off valve is usually installed in the pressure line so that the transmitter unit can be removed without emptying the fuel cell.

The hydrostatic system requires careful servicing. The system must be kept free from air and requires frequent bleeding. Vent lines must be blown out periodically and inspected for leaks.

System Errors

Scale Error

The scale error of any remote indicating system is approximately ±3° pointer movement. This includes the inherent instrument error as well as production tolerances. The instrument or scale error becomes quite large when considering a standard instrument dial $2^3/_4$ in. in diameter and having a range of 0–500 gal. or more. The scale range of the instruments is usually kept to about 350° pointer movement. This allows for a suitable indication of instrument power failure as well as indication of overfilled fuel cells.

Only a small part of the large error of a fuel measuring system is due to actual instrument error. The major portion is caused by variation of fuel density, volumetric expansion of the fuel, original calibration errors, and changes in flight attitude and in the design of the fuel cell itself.

Fuel Density Errors

The errors caused by variation in fuel density have never been given much consideration in the design of the fuel measuring devices. The usual practice is to pick an average value of specific gravity and calibrate the instrument accordingly. The variation in specific gravity of fuels from the average value is great enough to cause considerable error.

Fig. 3 is a chart showing the variation of specific gravity of fuel as a result of a country-wide survey of 91 octane fuels conducted between 1941 and 1943, inclusive. The values shown are the average values for each refinery over the 3-year record. The average specific gravity of all samples of fuel was to be 0.7173 or 5.971 lbs. per gal. The maximum difference between all samples of fuels was 5.6 per cent by weight. The maximum difference between the averages of refineries was 2.5 per cent. There is no accurate country-wide information available on 100 octane gasoline. One sample of 100 octane gasoline checked had a specific gravity of 0.7154 or a weight of 5.955 lbs. per gal. This figure falls within the average value of the 91 octane fuel.

REFINERY	SP. GR.	WT. LBS./GAL.
A	0.7254	6.038
B	0.7110	5.918
C	0.7197	5.991
D	0.7219	5.949
E	0.7219	6.010
F	0.7072	5.887

Fig. 3. Fuel survey 1941–1943.

The float-type fuel measuring system is not affected by the specific gravity of the fuel so far as volumetric measurements are concerned, but it is in error when considering the weight of the fuel per unit volume. The hydrostatic system, on the other hand, depends upon a fixed value of density for its accuracy.

Temperature Effects

The volumetric expansion and contraction of fuels due to temperature changes, as well as the specific gravity variation, have long been recognized by the air-line operators. Airplane ranges are usually considered on a fuel volume basis. That is to say, an airplane has a certain range for a certain number of gallons of fuel. Actually, however, the airplane range is determined by the pounds of fuel. To say that an airplane has a certain range with a certain number of gallons is to assume that the gasoline weight per gallon is constant. The density of the fuel must be considered in making airplane range calibration involving 1,000 gal. or more.

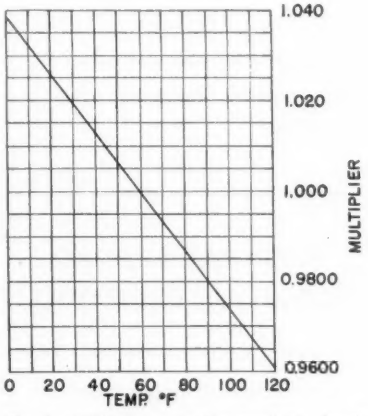

Fig. 4. Volume correction graph for aircraft fuels.

Fig. 4 is a graph showing the variation of volume with changes in temperature. The multiplier—that is, the volume of fuel measured at the indicated temperature—multiplied by the corresponding factor in the right-hand column equals the volume corrected to 60°F. For example, 100 gal. of fuel measured at 90°F. would be equal to 100 × 0.98 or 98 gal. at 60°F. The graph applies only to fuel having an API of 58°–71° or a specific gravity of 0.7467 to 0.6988.

Instrument manufacturers neglect the temperature effects in the design of fuel measuring devices. The usual practice is to calibrate the instrument at a fixed temperature. The errors due to volume changes are comparable to those of variation in specific gravity.

Calibration Errors

Initial calibration errors are not serious but do contribute to the total system error. In calibrating a fuel cell the airplane is set in level flight position, usually accomplished by setting the airplane on jacks. Known volumes of fuel are poured into the tank, and the necessary calibration instrumentation readings are taken after each volume has been poured. The instrument dials are calibrated to the data taken in this manner. The data, of course, are corrected for fuel temperature and density. The accuracy of the final production instrument is dependent upon the accuracy of the initial calibration.

Another possible source of error during the initial calibration can be caused by wing deflection. During the fueling operation the wings will deflect downward. In flight, however, the deflection will be upward. The error introduced in this manner is not constant but varies with the gross weight of the airplane at any particular time.

Measuring Points

Changes in flight attitude such as change in angle of attack or wing low positions will change the physical dimensions of a fixed volume of fuel and therefore give erroneous quantity indications. These errors may be reduced to a minimum by the proper choice of measuring points. In integral wing tank installation the choice of the measuring point would have to be a compromise. It is almost impossible to pick any one point where the error due to shifting fuel levels would be entirely eliminated throughout the whole instrument dial range. Good fuel cell design is also of importance. Only by careful baffling can the instrument pointer fluctuation due to splashing and shifting of fuel be kept to a minimum.

Fuel quantity gages are invariably calibrated in gallons, and yet fuel consumption is measured in pounds per brake horsepower hour. Unless the flight engineer or pilot knows the specific gravity of the fuel and applies suitable corrections, he will not be able to make any long-range calculation with reasonable accuracy.

Example

In order to appreciate fully the problem of fuel measurement, consider a fuel cell having the dimension 35 in. wide by 21 in. high by 180 in. long and having a usable capacity of 560 gal. It is installed in a wing having a dihedral of 9°. Fig. 5 is the calibration curve for this particular cell. The peculiar shape of the curve is due to the angle at which the tank is set. If the tank were set in a horizontal position, the calibration curve would, of course, be a straight line. From this calibration curve as standard, $2^3/_4$-in. diameter instrument dials can be marked as shown in Fig. 6. The dial is calibrated for 91 octane gasoline having a specific gravity of 0.7174 or 5.971 lbs. per gal. at 60°F. The dial graduations are not

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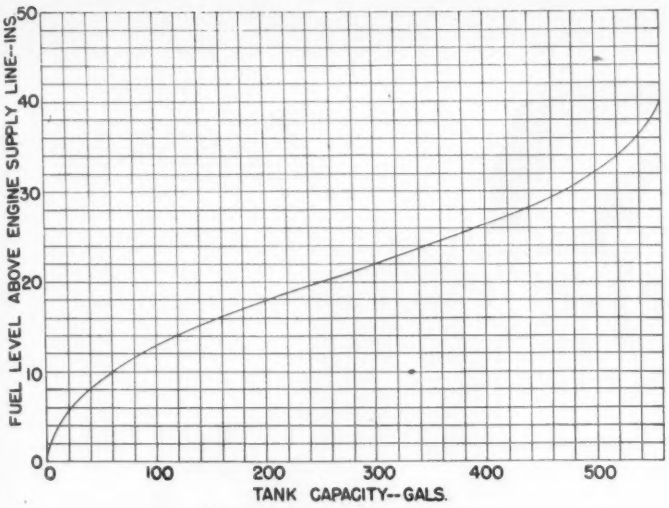


Fig. 5. Tank calibration curve.

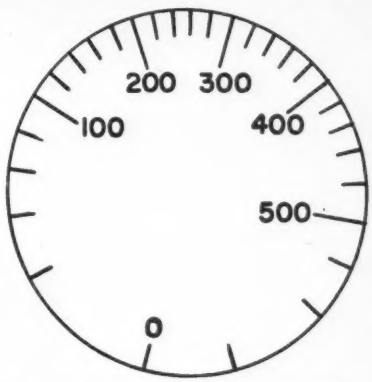


Fig. 6. Instrument dial for Fig. 5 tail calibration.

uniform, since the spread between each graduation is a function of shape and position of the fuel cell. This particular dial can be read with reasonable accuracy to ±5 gal. Assuming the instrument to be of the remote indicating type, it may have an average error of approximately 3 per cent.

In order to compare the errors of both systems for the particular fuel cell under discussion, consider a specific gravity variation of ±2.3 per cent and a temperature variation of approximately ±40°F. Using the volumetric multiplier of 1.025 and 0.975, the specific weight change for the temperature variation of ±40°F. is the same as a specific gravity variation of 2.5 per cent. Fig. 7 is a chart of the errors for each system, all calculations being based on temperature as specific gravity of the fuel at which the instrument was calibrated.

It will be noted that the float system has an average error of 2.5 per cent and 3.2 per cent for the hydrostatic system for a specific gravity variation of ±2.5 per cent or a temperature variation of approximately ±40°F. It must be realized, of course, that the magnitude of the errors in either system is a function of the shape of the tank angle at which the tank is installed. The errors in the hydrostatic system, however, are affected a great deal more by the physical dimensions of the fuel cell than the float-type system.

From the foregoing discussion, it is evident that with the present design and installation of either of the two basic types of measuring systems that an error of as high as 10 per cent by weight can be expected. This figure includes the errors that are introduced into the system by variation as specific gravity of the fuel, change in fuel temperature, change in flight attitude, initial tank calibration errors, and selection of proper fuel measuring points.

Conclusions

Unless rapid advances are made in the design of fuel measuring devices, the air lines will be forced to use the fuel flowmeter as a means of computing with reasonable accuracy the quantity of fuel remaining in the tanks. The determination of fuel quantity in this manner would be rather laborious in that the flowmeter would have to be closely watched. The fuel flow would, of course, vary with changes in horsepower, and, consequently, the fuel-flow reading would have to be clocked for each horsepower. It is true that fuel quantity indicators will still have to be used as a check on the fuel quantity measurements as determined by the flowmeter and for the purpose of detecting fuel cell leaks during flight.

In long-range air-line operation the pay load would probably be less than 30 per cent of the gross weight of the airplane. The total fuel load may be as high as 25 per cent of the gross weight. Any small decrease in reserve fuel load required because of errors in fuel quantity may substantially increase the pay load of the airplane.

Recent C.A.A. Regulations limit airplanes in air-line operation to a landing speed of 80 m.p.h. The landing speed is, of course, dependent upon the gross weight of the airplane. The marked difference between the maximum take-off gross weight and the maximum landing gross weight requires accurate load control from the flight-originating point to the flight destination. The only flight load variable, of course, is the fuel and oil load.

For all general types of power control such as maximum endurance range, maximum range operation, maximum speed operation, etc., accurate gross weight of the airplane must be known at all times.

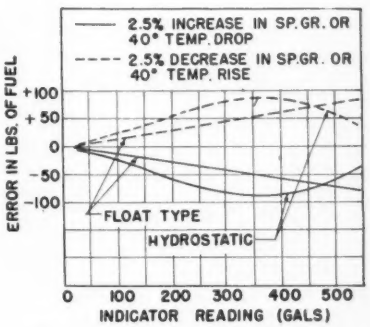


Fig. 7. Approximate fuel indicator error due to ±2.5 per cent change in specific gravity or ±40° temperature variation.

The general requirements for a fuel quantity indicating system are as follows:

(1) The total indicating system error should not exceed 3 per cent.

(2) The system shall automatically compensate for variation in fuel density and fuel temperature.

(3) The system shall not be affected by changes in flight attitude or accelerated flight conditions such as sudden changes in altitude.

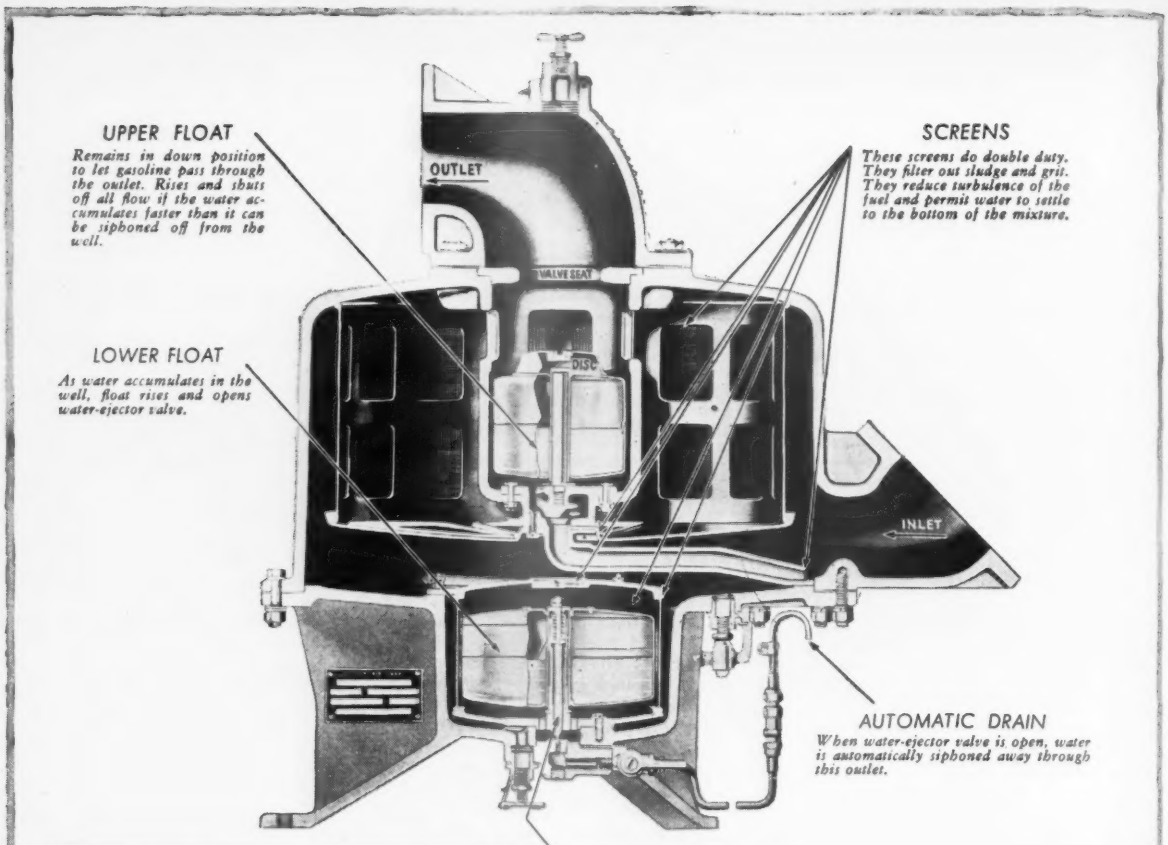
(4) All parts of the system shall be readily replaceable without the necessity of draining the fuel tanks.

(5) All parts of the system shall be interchangeable wherever possible.

(6) The servicing of the system shall coincide with the airplane inspection period.

(7) The need for replacement of any part of the system shall coincide with the engine change period.

(8) The weight of the system shall be kept to a minimum. The weight consideration, however, should be a compromise. The reliability and serviceability of the various component parts must not be sacrificed in lieu of weight-saving.


UPPER FLOAT
Remains in down position to let gasoline pass through the outlet. Rises and shuts off all flow if the water accumulates faster than it can be siphoned off from the well.
LOWER FLOAT
As water accumulates in the well, float rises and opens water-ejector valve.
OUTLET
VALVE SEAT
DISC
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SCREENS
These screens do double duty. They filter out sludge and grit. They reduce turbulence of the fuel and permit water to settle to the bottom of the mixture.
AUTOMATIC DRAIN
When water-ejector valve is open, water is automatically siphoned away through this outlet.
WATER-EJECTOR VALVE
A needle valve—opened and closed by the travel of the lower float.

says "YES" to gasoline "NO" to water

Army engineers developed it...
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To ensure a positive shut-off when this occurs, the floats are fitted with special valve discs that are rustproof and highly resistant to corrosion—*Monel valve discs.*

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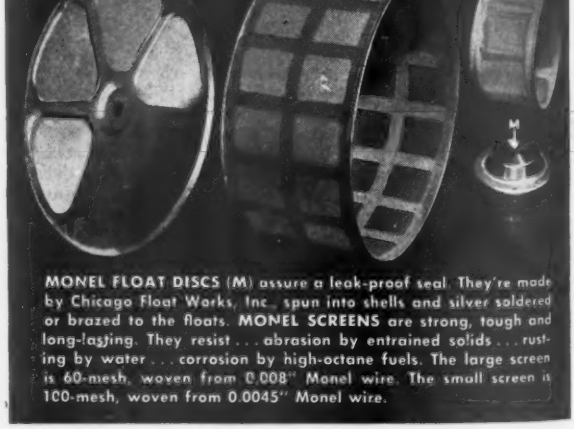

MONEL FLOAT DISCS (M) assure a leak-proof seal. They're made by Chicago Float Works, Inc., spun into shells and silver soldered or brazed to the floats. **MONEL SCREENS** are strong, tough and long-lasting. They resist... abrasion by entrained solids... rusting by water... corrosion by high-octane fuels. The large screen is 60-mesh, woven from 0.008" Monel wire. The small screen is 100-mesh, woven from 0.0045" Monel wire.

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The Air Position Indicator

ARTHUR WAHL*

Air Technical Service Command

Introduction

Air navigation has frequently been called an art rather than a science because the success with which the many variables are combined in its execution depends to a large extent upon the navigator's ability to anticipate the unpredictable; to integrate by eye; and then to attach, sometimes arbitrarily, the proper weight to each factor in order to obtain the desired result or "hit the objective on the nose." Another reason for this classification is that air navigation consists of no one system, and the navigator must be able to make optimum use of all systems or aids available to him: dead reckoning, celestial, pilotage, and radio—all of which are affected by meteorological data or weather conditions. The aim in the design and development of navigation instruments is to make each component factor as accurate and dependable as possible, to reduce the number of extraneous variables, and to combine automatically as many of the essential variables as possible. The last function is one performed by the air position indicator, whose value can best be appreciated after a process of descriptive evolution of the essential variables.

Dead-Reckoning Navigation

Consider now the system of air navigation known as dead reckoning, which is a process of noting the speed of the aircraft over the ground and the direction in which the aircraft is traveling from a known starting or reference point so that its instantaneous geographical coordinates can be determined at any time. Such a system may at first seem simple enough, but consider further the details involved in obtaining and combining these data by means of elementary instruments consisting of a direct-reading magnetic compass, an air-speed indicator, a thermometer, an altimeter, and a driftmeter.

The direct-reading magnetic compass is the source from which the direction of flight is determined, but a great many factors contribute toward making erroneous the data that it yields. In the first place, local magnetic disturbances, inherently occurring in the aircraft at places where the compass must be located, prevent the compass from giving the proper reading. The error introduced always varies with heading and is frequently an erratic and changeable function so that accurate calibration of the instrument is of little avail. Furthermore, if the air is rough, even an attempted straight flight causes the compass to oscillate at random, forcing the navigator to average the indication by eye as best he can.

At best, the navigator must combine the deviation of the compass on a particular heading with variation, the angle between magnetic north and true north, and then possibly estimate an average of a fluctuating indication in order to determine the correct heading of the aircraft. He must also take an indicated air speed, which is a measure of the impact pressure as the aircraft travels through the air, correct it for scale error and installation error, and combine it with temperature and altitude to arrive at the true speed of the aircraft through the air. From these data he can determine his air plot or his position with respect to the air mass in which he is traveling. Then in case a wind is blowing (the air in which he is traveling is in motion), he can determine the wind velocity and direction by means of his driftmeter, correct his heading accordingly so that he flies over the ground in the proper direction, and be prepared to combine his air position with the wind vector over any specified period of time in order to spot his ground position.

All of the foregoing description was based upon constant factors of heading —air speed and altitude. As changes in direction, speed, and altitude occur, the job becomes more complicated; during evasive action it is virtually impossible. Now let us examine the refinements of the essential factors and how these refinements simplified the job and led to the combination of these essential factors.

The Remote Indicating Compass

With the advent of the remote indicating gyro-stabilized magnetic compass, the magnetic sensitive element could be placed in the outer wing, where it would be little affected by local magnetic disturbances in the fuselage. Furthermore, any resultant deviation, small and constant, could be compensated out so that the indicator would read the magnetic heading directly. In addition, the gyro stabilization produced a steady indication even in rough air, responsive only to changes in azimuth, and provided an electrical azimuth signal that could be amplified for power take-off to other instruments. The latter feature is entirely absent in a direct-reading magnetic compass.

The Air-Speed System

In refining the air-speed system, the British hit upon an ingenious scheme whereby the impact pressure of the pitot tube is balanced against pump pressure of a centrifugal blower in such a way that altitude and temperature factors are eliminated, with the result that the speed of rotation of the driving motor in the pump is directly proportional to the desired true air speed.

With accurate compass and true air-speed indications, which require no further corrections, the navigator's job of maintaining an air plot would be greatly simplified, particularly on straight flights. When changes in air speed and direction occur frequently, he must again average by eye the instantaneous readings and combine them properly to maintain his plot. The job increases in difficulty during frequent turns and speed changes and approaches impossibility during evasive action.

Frequently, requests have arisen for an averaging compass or an averaging air-speed indicator, but such individual average readings could be misleading unless tied together. For example, if an airplane flew east at 200 m.p.h. for 1 hour and then north at 200 m.p.h. for 1 hour, the actual resultant average heading would correspond with the chronometric average. However, if it flew east at 200 m.p.h. for 1 hour and then north at 300 m.p.h. for 1 hour, the resultant chronometric average for 2 hours would be erroneous. The average heading is thus also a function of speed.

Air Position Indicator

The air position indicator, briefly called API, combines the rotational speed of the true air-speed pump with the directional signal from the compass and produces continuous indication of the air plot in latitude and longitude. Proper application of the wind vector (the distance by which the air mass has moved over a specified period of time) to this air position yields ground position. The readings of latitude and longitude appear on two drum-type counters, which are initially set to the proper latitude and longitude of the take-off

Received December 4, 1944. To have been presented at the I.A.S. Thirteenth Annual Meeting, which was canceled to cooperate with a Government appeal (January, 1945) to refrain from holding conventions and meetings.

* Captain, Air Corps. Equipment Laboratory, Engineering Division.

Ready: Collins Transmitters for airport applications

Collins Autotune Transmitters

IN DESIGN AND CONSTRUCTION the Collins Autotune transmitters, shown below, reflect extensive laboratory and field research, and intense engineering endeavor, both before and since Pearl Harbor. The most advanced refinements are combined with military ruggedness on a production line basis!

The Collins Autotune is a repositioning mechanism which quick-shifts all tuning controls simultaneously and with extreme precision to any one of ten preselected frequencies at the flip of a dial, either at the transmitter or from a remote point. The standard models are crystal controlled, and special models are available with tunable master oscillator control.

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Frequency-shift keying is available, making it possible to use these transmitters in printing telegraph circuits.

Collins Multi-channel Transmitters

THE COLLINS 1000-C 2500 watt multi-channel airport transmitter shown at right, below, provides an ingenious balance of quality, efficiency and economy. The radio frequency cabinet contains two vertical r.f. sections. Each section can be used interchangeably on two channels located anywhere within 2 to 20 Mc. The cost per section compares with that of conventional single channel sections. The cost per channel is thus cut approximately in half. In addition, relays permit selection of three crystals per channel (six per vertical section). Twelve frequencies are therefore available in a single cabinet.

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Your inquiry is invited. We will be glad to make recommendations for your particular applications.

Collins 231D-13—Nominal power output: 3000 watts phone; 5000 watts c.w. Frequency range: 2 to 18 Mc. Ten quick-shift frequencies.

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ARMY E NAVY

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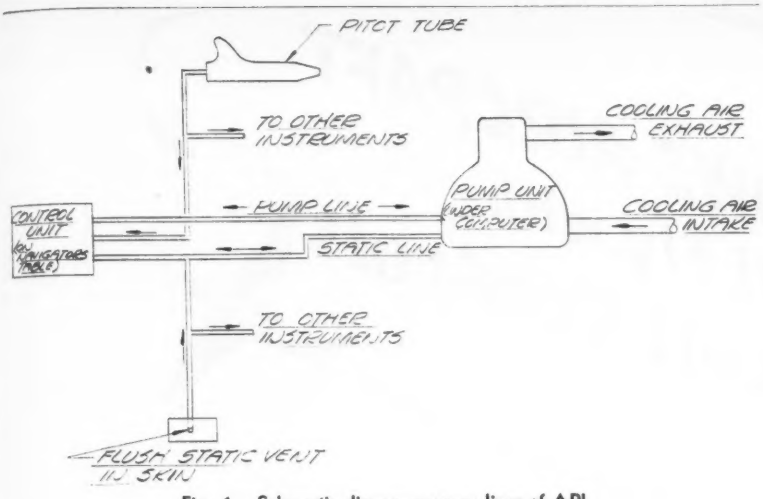

Fig. 1. Schematic diagram pressure lines of API.

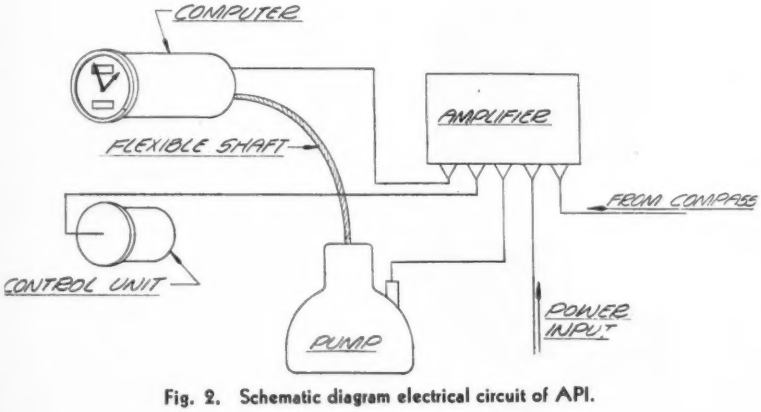

Fig. 2. Schematic diagram electrical circuit of API.

point and can be reset anytime when passing over a check point in flight. The indicator, more specifically called the computer, also registers total air miles traveled and has a compass dial and pointer that must necessarily indicate heading with respect to true north.

Operation of the instrument consists of first seeing that the compass is in proper operation, energizing the API, and setting the counters to the proper latitude and longitude before take-off. During the take-off run, the true airspeed pump begins to operate at about 70 or 80 m.p.h., and the API then swings into operation. Magnetic north variation must be set in manually, a degree at a time, as the flight progresses in order that the compass input reference is true north for resolution into geographic coordinates.

Wind must be determined by any external means available but can be determined by the API itself by noting the difference in air position as read on the API and ground position as determined by a check point, after flying for about 40 min. from a point where the API was set to ground position. The wind thus determined can be used for future flying until a wind shift is suspected or observed and is frequently more suitable than a wind determined by double drift because the latter is a spot wind whereas the former is an average wind. However, double drift observations should be taken at regular intervals for check.

The air position indicator, as in use by the Army Air Forces, today consists of an assembly of four units, exclusive of the compass: the pump, the controller, the amplifier, and the computer.

The Pump and Controller

The pump consists simply of a d.c. series motor with a centrifugal blower or fan mounted on its shaft. These are housed in a suitable casing with a compartment around them for circulating outside air in order to maintain them as nearly as possible to outside air temperature. Static pressure of the outside air is led into the axis of the centrifugal blower, which generates a differential pressure above this static pressure as it runs. The motor also carries a gear reduction to which is connected the output shaft to the computer.

The pressure generated by the pump is fed into one diaphragm in the controller. The other diaphragm in the controller receives pitot pressure, and together these two control a switch to the driving motor in the pump. In attempting to keep the pressures in these two diaphragms matched, the pump speed varies with pitot pressure, and in doing so its speed of rotation is directly proportional to true air speed. Actually, mathematical analysis shows that the variation of pressure with rotational speed generated by the pump is an exponential function, but by proper design the linear portion of the curve is chosen for the operating range. The pump and controller function hand in hand and could be designed into one integral unit, as in the British system. Both the British and American systems are designed so that 24 revolutions of the output shaft represent 1 nautical mile.

Computer and Amplifier

The rotational speed from the pump motor is fed into the computer, which employs the well-known ball-disc integrator scheme. The pump motor actually drives two disc plates, one for latitude and one for longitude. The latitude disc plate drives by friction a ball, which in turn drives a cylinder geared directly to the latitude counter. The speed and direction of rotation of the cylinder and of the counter is directly proportional to the speed of the disc plate and the radial position of the ball on the disc plate. This radial position is determined by the input compass signal through the API amplifier. The mechanism is assembled in such a way that the latitude counter is driven at a speed proportional to true air speed $\times \cos \theta$, where θ is angle of true heading.

The longitude counter is driven in the same manner as the latitude counter, except that the speed of rotation of the counter is proportional to true air speed $\times \cos \theta \times \sec \phi$ where ϕ is latitude. The secant function is inserted by a disc-plate ball scheme in reverse. The complete chain of motion transmission is then disc plate to ball to cylinder, which is geared to another cylinder driving another disc plate through a ball. The radial position of the ball on the last disc plate is determined by the latitude. The longitude counter is geared directly to the last disc plate.

This secant function accounts for the convergence of meridians. If it were not present, the longitude counter would

Fig. 3. Face view of API computer.

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Creative engineering has enabled Honeywell to more than meet the aeronautical demands of war. This same creative engineering and its resultant revolutionary accomplishments will help to fly tomorrow's aircraft. Honeywell's research program includes a complete flight research department, test aircraft, and thousands of dollars worth of testing equipment. In addition, trained application engineers will collaborate with aircraft manufacturers and airlines in developing the most practical equipment for each specific problem. Their work includes consulting service and flight testing at customers plants. These men can help you in the application of Honeywell equipment to your control problems of tomorrow as well as today. Minneapolis-Honeywell Regulator Company — Aeronautical Division, 2700 Fourth Ave. S., Minneapolis 8, Minn.

AUTOPILOT — Honeywell's experience in the production and maintenance of more than 30,000 autopilots is the foundation for a new light-weight pilot now in the design stage. Gyros are being developed either for instrument panel mounting or for remote installation. All-electric servos will provide smooth accurate control operation and instant disconnect. Control circuits will permit either gyroscopic or compass control of airplane heading and easy adaptation to blind landing equipment. Other anticipated features include emergency engaging, automatic synchronization, and a "ride control" for quick, easy adjustment of flight characteristics.

FUEL QUANTITY INDICATOR — By measuring the capacitance between two concentric tubes, a new electronic fuel gage indicates the quantity of gasoline in fuel tanks and automatically compensates for temperature variations. The tank unit contains no floats or other moving parts and may be inserted in the tank either from top or bottom. Any number of tank units may be operated with a single, remotely installed amplifier and motor driven indicator. The 270 degree indicator employs a follow-up device which automatically rebalances to the null-point, thereby assuring extreme accuracy all the way from FULL to EMPTY.

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Makers of the famous M-H Electronic Autopilot, used on AAF four-engined bombers

MINNEAPOLIS Honeywell CONTROL SYSTEMS

integrate in departure, and the resultant reading would be unsuitable for navigational purposes in latitude and longitude. For example, because of meridian convergence, a nautical mile is 1 min. of longitude at the equator but 2 min. of longitude at 60° latitude. For the same air speed the longitude counter must turn twice as fast at 60° latitude. In the present instrument the range of operation is to 80° latitude, where the expansion is approximately six to one. Beyond this, slipping begins in the friction drives. Obviously, the system must break down somewhere, because near the pole the longitude counter would approach an infinite speed of rotation.

The secant factor just described is not absolutely correct but is close enough for all practical purposes. It would be exact if the earth were a perfect sphere, but the earth is actually slightly flattened at the poles. However, the error introduced is insignificant.

Other System Requirements

From the foregoing description it can be seen that when in proper operation the air position indicator gives a continuous indication of the air position, regardless of changes in direction and speed. As mentioned before, the wind vector must be added to the air position to obtain ground position, but the effect of the wind is the same, regardless of the type of flying done, from straight and level to violent evasive action. To have the API in proper operation, however, depends upon a number of external factors, which will now be discussed.

In the first place, the airplane must have an accurate pitot-tube installation and an accurate flush static installation. If either or both of these are in error, the error will, of course, reflect directly into the API. An accurate flush static location in the skin of the airplane must be found by trial for each type of airplane. Once determined, the location can be used for all airplanes of the same type.

The airplane must also have a magnetically good location for the remote compass transmitter. Actual magnetic deviations of a few degrees on the compass can be tolerated if they remain fixed. Provision is made for mechanically compensating out such deviations and fixed transmission errors, so that the compass input is accurate to within 1° on all headings. The importance of the accurate compass calibration can be better understood when it is realized that an error of 1° in heading means an error of 1 mile in approximately 60 miles, or about $1^2/_3$ per cent.

Suitable provision must also be made for cooling the centrifugal fan of the air mileage pump with air from the outside. This is accomplished by means of an intake opening, which is flush with the skin of the airplane, and an exhaust pipe, which protrudes through the skin of the airplane with an opening facing aft so that the cooling air is drawn through, rather than pushed through. The ideal and desired condition is that the pump be at outside ambient air temperature because its theory of operation is based upon this condition. However, it is always slightly warmer because of adiabatic heating, since the cooling air is virtually stopped with respect to the airplane. This heating causes some error in the resultant true air speed, and this error must be accounted for in the calibration of the controller.

Conclusions

The air position indicator, when properly operated as described previously, gives the navigator a continuous indication of his air plot. However, it cannot be called an automatic navigator and was never intended to replace the navigator. Its purpose is to act as an aid to the navigator, to do his job of dead reckoning for him when his other means become impossible (such as during evasive action), to carry on for him over limited periods of time when he must leave his work to do other jobs such as operate guns, and to perform any other functions that a clever navigator might find for it. Such other functions include keeping account of distance traveled between celestial shots, determining winds, aiding in computing gasoline consumption and range, and many others that only time and use will uncover. It can also be used on long straight flights but is really not necessary because of the simplicity in performing such a task with the elementary instruments mentioned previously.

The air position indicator does require proper installation and calibration before it *can* give satisfactory results. It requires some care, attention, and knowledge of how to operate it on the part of the navigator before it does give satisfactory results. As such it can never be classed among the elementary instruments, which require no attention on the part of the operator and need only be glanced at from time to time in order to obtain a proper reading. Experience and common sense have shown that the instrument requires some education and training of the navigator before he can use it successfully.

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A General Method for Estimating Wing Weights

JOHN B. SCALZI*

Curtiss-Wright Corporation

SUMMARY

This paper presents a general expression for estimating the weight of an airplane wing. The method is a combination of structural analysis and statistical data to yield an expression that may be easily and rapidly applied. The expression is established with the aim of estimating the major components of the wing separately, so that the effect of each on the total weight of the wing may be studied and analyzed. The equation is applicable to any type of wing construction for which there are sufficient constants available. The constants to be applied to a new design should be derived from a previous design of similar construction to ensure greater accuracy of the final estimate. For designs that are extremely unconventional or radically different, the formula must be applied with complete engineering discretion and sound judgment.

INTRODUCTION

THE WEIGHT ESTIMATION of the structural components of the airplane has always been a difficult and annoying problem with no apparent solution. In fact, it will remain an uncertain evaluation as long as designs continue to improve and new ideas are developed for structural construction. No two airplanes are ever built in the same manner; therefore their weights cannot be expected to be correlated except as a general tendency. Nevertheless, weights must be estimated for new proposals and a sound engineering basis for all decisions must prevail. This background of engineering judgment is acquired only after many years of experience in the field and a thorough knowledge of the structural considerations involved. Statistical data compiled by a definitely established system are a direct aid in substantiating the analytical estimates. As one would imagine, the best method of estimation is based upon the stress analysis considerations of the ultimate design loads that are to be carried and the special design features of the structure. The weight engineer is also aware of the fact that in some instances this method is impractical to apply. Then statistical data and sound engineering judgment must be resorted to.

Methods of estimating the weight of a wing are numerous. Each method has its specific application and resulting drawbacks. The main reason for such a large variety of expressions is the countless variable factors affecting the wing weight. The most important of these variables are the wing loading, aspect ratio, taper ratio, thickness ratio at the root and tip, the allowable stresses in shear and bending, ultimate flight load factor, gross wing area, type of design and construction, the project engineer's point of view on weight, and the general efficiency of the structural analysis. Some of these may be accounted for on an analytical basis, while others are completely indeterminate. To compensate for this deficiency, assumptions must be made to combine these intangible variables into a constant.

Received December 4, 1944.

* Senior Stress Analyst, Buffalo Plant.

SYMBOLS

A_s	= area in shear
A_b	= area in bending
b	= span
C	= chord
C_m	= mean chord = S/b
f_s	= allowable shear stress
f_b	= allowable bending stress
k	= constant
K_s	= coefficient for shear
K_b	= coefficient for bending
M	= bending moment
n	= ultimate flight load factor
ρ	= unit weight of material
S	= gross wing area
t_t	= tip thickness in inches
t_r	= root thickness in inches
V	= total shear
W	= design gross weight
TR	= taper ratio (root chord/tip chord)
AR	= aspect ratio
W/S	= wing loading

Subscripts t, r, and x refer to tip, root, and section, x, from the tip, respectively.

METHOD OF ANALYSIS

In order to establish an equation for wing weight that would include as many as possible of the variable factors, it was necessary to revert to a consideration of the basic structural analysis of the wing. On this basis, the wing weight is considered to be composed of several items such as shear weight, bending weight, skin and rib weights, and the weights of the provisional items in the wing. The factors affecting the shear and bending weights that will be considered are wing loading, load factor, aspect ratio, gross wing area, plan taper ratio, root and tip thickness in inches, allowable stresses in shear and bending, span, and design gross weight. The span will be considered with the aspect ratio and therefore will not appear as a separate factor in the final expression. The gross weight will be considered with the wing loading.

SHEAR WEIGHT

To derive an expression that will evaluate the shear weight, the effect of each variable will be considered acting singly, while the remaining factors are maintained constant. The shear material is defined as that portion of the wing that resists the shear loads. For this derivation the shear material is considered to be the beam webs only.

Wing Loading: The effect of wing loading on the shear weight is to increase the weight linearly with increase in the wing loading. This is true, since the total shear at any section of the span varies linearly with the wing loading and since the cross-sectional shear area is proportional to the total shear. This evolves from the simple equation that the shear area equals the total shear divided by the allowable shear stress:

$$A_s = V/f_s$$

Allowable Shear Stress: From the expression above, it is easily seen that the shear weight varies inversely as the allowable shear stress.

Ultimate Flight Load Factor: Experience has shown that the maximum ultimate flight load factor will produce the greatest loads on the major portions of the wing structure. The effect of the load factor is to increase the wing loading proportionately; therefore from above, the shear weight varies directly as the ultimate flight load factor.

Thickness: The cross-sectional area of the shear material determines the amount of weight involved regardless of its geometrical proportions. This is easily derived from the expression given in the wing loading discussion. Therefore, it may be stated that the thickness at the root and tip do not affect the shear weight and will not appear in a general equation.

Aspect Ratio

To determine the effect of aspect ratio the following derivation is presented. Since the aspect ratio is the only factor that will be considered to vary, the taper ratio may be assumed to be unity for the purpose of this analysis. This assumption permits the use of a rectangular plan form as shown in Fig. 1. The chord is constant throughout the

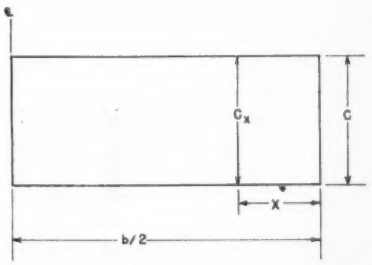

Fig. 1.

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Already, Holley Carburetors are playing an important part in this epochal expansion. Through experience gained in millions of miles of wartime flying, Holley research advanced and improved aviation carburetion during war years. Now, as this new era in transportation gains momentum, Holley will, as it has done for almost half a century before, set the standards of dependable carburetor performance.

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CARBURETORS AND ACCESSORIES

semispan and is equal to the gross wing area divided by the total span, $C = S/b$. The total shear at any section, x, from the tip is proportional to the chord, since the wing loading is assumed to be the average wing loading. The average wing loading is defined as the total load on the wing (gross weight) divided by the gross wing area.

$$V_x = k\int_0^x C\,dx \qquad (1)$$

where the mean chord is $C_m = (S/AR)^{1/2}$.

Substituting in shear expression

$$V_x = k\int_0^x (S/AR)^{1/2}\,dx \qquad (2)$$

$$V_x = k(S/AR)^{1/2}\,x \qquad (3)$$

and the shear weight $= \rho\int A_x\,dx$.

The area required to carry shear at any section, x, is

$$A_x = V_x/f_s$$

$$\text{shear weight} = \frac{\rho k}{f_s}\int_0^{b/2}\left(\frac{S}{AR}\right)^{1/2} x\,dx = k(AR)^{1/2}(S)^{3/2} \qquad (4)$$

The above expression indicates that the shear weight varies linearly with the square root of the aspect ratio. Fig. 2 shows the qualitative variation of the shear weight with the aspect ratio.

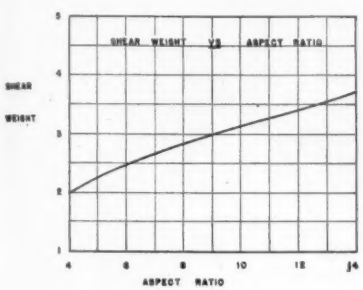


Fig. 2.

Wing Area

The derivation for aspect ratio may also be used to indicate the variation of the shear material with the gross wing area. It may be determined that, when all other factors are maintained constant, the shear weight varies linearly with the three-halves power of the gross wing area. Fig. 3 shows the qualitative variation of the shear weight with the gross wing area.

Taper Ratio

The effect of the taper ratio on the shear weight is determined in the following manner:

The plan form shown in Fig. 4 indicates that for any change in the taper ratio there is a corresponding change in the chord length at all sections. The chord at any section, x, from the tip may be expressed as follows:

$$C_x = \frac{S}{b\left(1+\frac{TR-1}{2}\right)} \times \left[1+(TR-1)\frac{2x}{b}\right] \qquad (5)$$

The total shear at section, x, is

$$V_x = k\int_0^x C_x\,dx$$

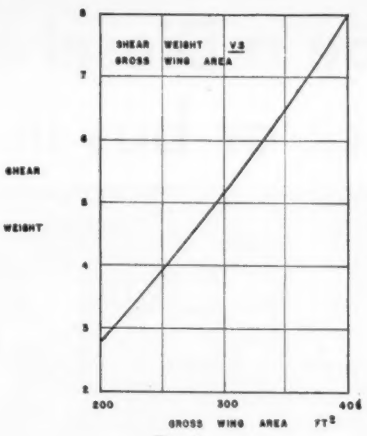


Fig. 3.

or

$$V_x = k\int_0^x \frac{S}{b\left(1+\frac{TR-1}{2}\right)} \times \left[1+(TR-1)\frac{2x}{b}\right]dx \qquad (6)$$

The shear weight is equal to $K\int_0^{b/2} V_x\,dx$.

Substituting for V_x and integrating, the shear weight may be expressed as follows:

$$\text{shear weight} = K'(TR+2)/(TR+1)$$

Fig. 5 shows the qualitative variation of the shear weight with the taper ratio.

Total Shear Weight

The individual effects of the major geometrical factors of the wing may be combined to yield a general expression for the total shear weight in the wing,

$$\text{shear weight} = K_s\left(\frac{n}{f_s}\right)\left(\frac{W}{S}\right) \times \left(\frac{TR+2}{TR+1}\right)(AR)^{1/2}(S)^{3/2} \qquad (7)$$

The coefficient K_s is a proportionality factor that is determined from a previous similar design.

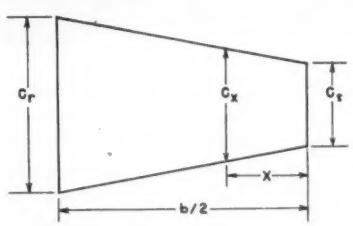


Fig. 4.

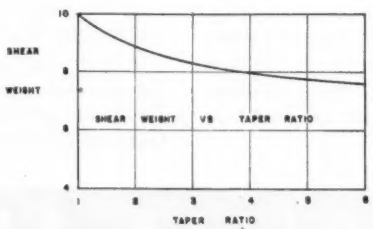


Fig. 5.

Bending Weight

The procedure that was used to develop the shear expression will also be used to investigate the effect of the various factors on the bending weight of the wing.

The bending weight shall be considered as that material in the wing that resists the bending of the wing. Although the skin shares in the labor of resisting the bending moment, it shall be neglected. The bending material is assumed to consist of the beam flanges or capstrips only.

Wing Loading

The effect of the wing loading on the bending weight is to increase the bending weight linearly with the increase in the wing loading. This is true, since the bending moment varies directly with the wing loading and since the cross-sectional area resisting the moment is directly proportional to the bending moment.

Ultimate Flight Load Factor

Similar to the shear expression, it may be seen that the bending weight is directly proportional to the ultimate flight load factor.

Allowable Bending Stress

It is assumed that the cross-sectional area in bending is determined by the simple expression of

$$A_b = M/tf$$

This expression indicates that the bending weight varies inversely with the ultimate allowable bending stress.

Aspect Ratio

On the basis of the assumption made in the discussion of the allowable bending stress that the area, $A_b = M/tf$, the bending weight at any section, x, may be expressed in the following general form:

$$\text{bending weight} = \frac{k\rho}{f_b}\int\frac{M_x}{t_x}\,dx \qquad (8)$$

The moment at any section, x, is $M_x = \int V_x\,dx$.

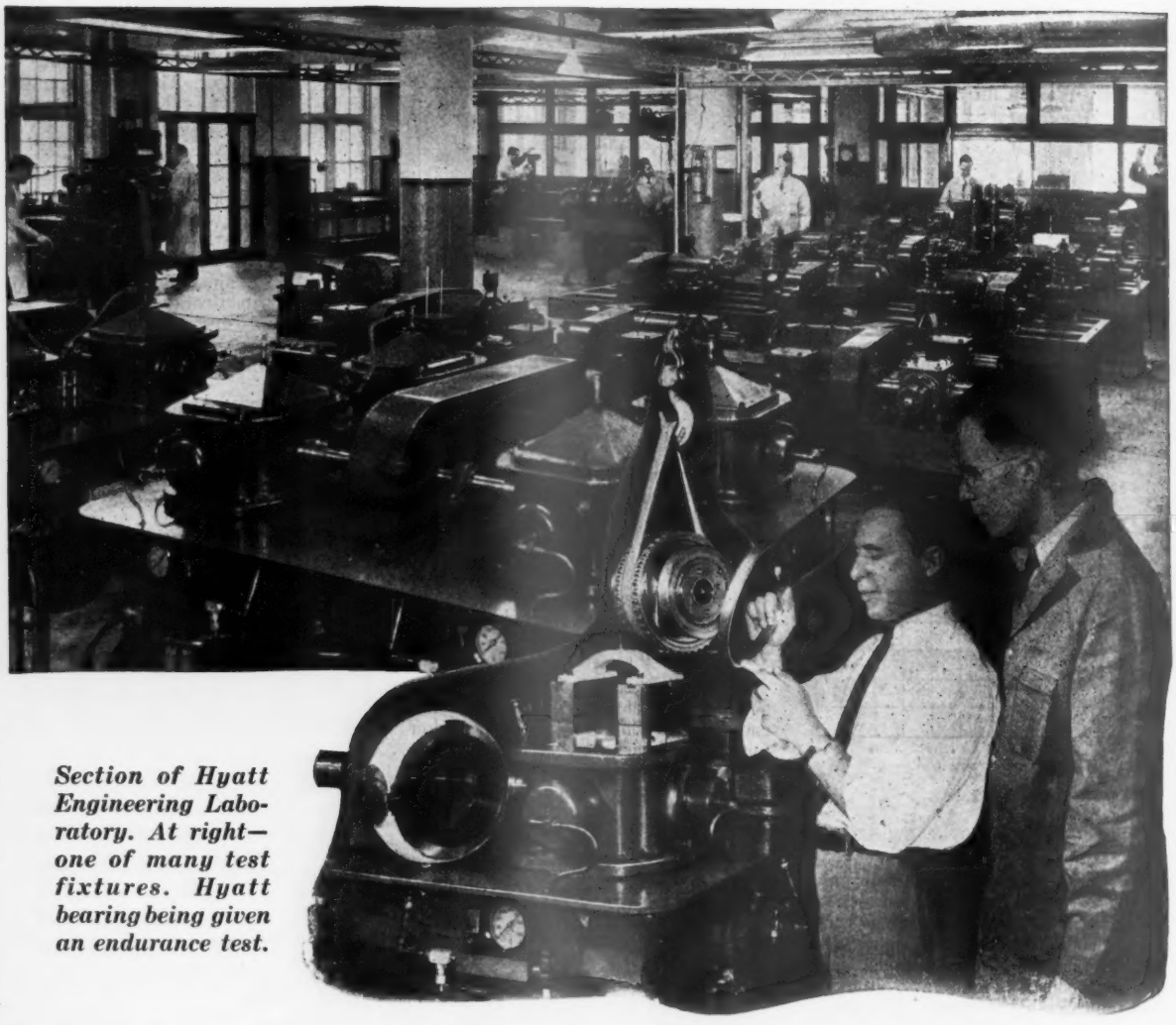
Substituting for V_x as determined in the shear expression,

$$M_x = k\left(\frac{S}{AR}\right)^{1/2}\frac{(x)^2}{2} \qquad (9)$$

Since only the aspect ratio is permitted to vary, the thickness will be assumed constant, such that $t_x = t$. This assumption is made at this time to indicate the theoretical approach of the derivation. It may be justified by the fact that for purposes of weight estimation many other factors cannot be determined and the final expression thus derived is one of direct proportions of one airplane with another. For the expression to be theoretically true, the moment and thickness must be considered simultaneously. Then

$$\text{bending weight} = \frac{k'}{t}\frac{\rho}{f_b}\int_0^{b/2}\left(\frac{S}{AR}\right)^{1/2} \times x^2\,dx = K(AR)S^2 \qquad (10)$$

There may be a Diesel locomotive... a car, truck or bus in this room



Section of Hyatt Engineering Laboratory. At right—one of many test fixtures. Hyatt bearing being given an endurance test.

EACH DIFFERENT TYPE of application makes its own special demands of Hyatt Roller Bearings—with such destructive forces as speed, impact, radial or thrust loads, and others—as well as conditions of moisture, wetness, heat, cold, dust, dirt.

It is traditional to build Hyatts with endurance to outlast the equipment for which they are designed. Our way of making sure of their capacity to do so is to simulate the conditions of the job—whether it's that of a massive locomotive journal box, an automotive differential, transmission or wheel—in our 24-hour-a-day testing laboratory.

Here, dozens of individual tests go on all the time—even to running bearings to destruction to prove their correctness of design.

Any bearing, in any stage of production may be picked for these tests by Hyatt's roving test engineers. This random selection is added assurance to the Hyatt Roller Bearing user that both workmanship and metallurgical standards are adhered to throughout the entire manufacturing process.

Hyatt engineers gladly consult with you on the selection of the proper Hyatt Roller Bearings for your product. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.

HYATT ROLLER BEARINGS

The equation indicates that the bending weight varies linearly with the aspect ratio.

Wing Area

Using the derivation for the effect of the aspect ratio given above, it is seen that the bending weight varies directly as the square of the gross wing area.

The effect of a change in taper ratio while all other values are held constant is determined below.

Let ABCD be a rectangular plan form (Fig. 6) and A′B′CD be a tapered plan form with the same area. The taper ratio may then be expressed as:

$$TR = (C_m + d_0)/(C_m - d_0)$$

where

$$d_0 = C_m(TR - 1)/(TR + 1)$$

The distance, d, at any section, x, from the tip is

$$d = d_0[1 - (4x/b)]$$

Shear at section, x, is $V_x = k\int_0^x C_x\,dx$ where $C_x = C_m - d$. Substituting and rearranging terms,

$$V_x = k[C_m x - d_0 x + (2d_0x^2/b)] \quad (11)$$

The bending moment at section, x, is $M_x = k\int_0^x V_x\,dx$. Substituting the value of V_x and integrating,

$$M_x = k\left(\frac{C_m x^2}{2} - \frac{d_0x^2}{2} + \frac{2d_0x^3}{b3}\right) \quad (12)$$

Bending weight $= K\int_0^{b/2}(M_x/t)\,dx$. The derivation is based on the assumption that the thickness remains constant throughout the span.

Substituting for M_x and integrating,

$$\text{bending weight} = K''(TR + 3/TR + 1)$$

This relationship is shown plotted in Fig. 7.

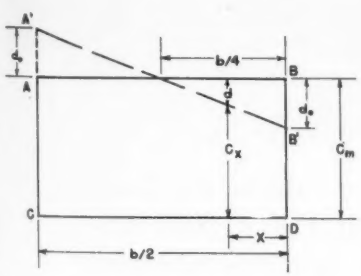


Fig. 6.

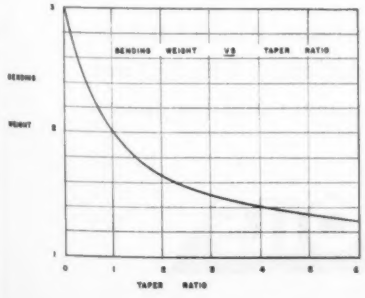


Fig. 7.

Root and Tip Thickness

The following discussion analyzes the effect of a change in the tip and root thicknesses on the bending weight.

From a consideration of the chord and thickness at section, x, a general expression is derived for the thickness at section, x, in terms of the tip and root thicknesses, such that,

$$t_x = t_t\left(1 - \frac{x}{b/2}\right) + \frac{t_r x}{b/2} \quad (13)$$

As previously,

$$\text{bending weight} = k\int_0^{b/2}(M/t)\,dx \quad (14)$$

The bending moment will be considered constant since it is independent of the thickness. The equation then becomes

$$\text{bending weight} = k\int_0^{b/2}\frac{dx}{t_t\left(1 - \frac{x}{b/2}\right) + \frac{t_r x}{b/2}} \quad (15)$$

or

$$\text{bending weight} = K\left[\frac{\log(t_r/t_t)}{t_r - t_t}\right]$$

The effect of varying either the root or tip thickness is shown in Figs. 8 and 9, respectively.

Total Bending Weight

The effects of all the individual factors may be combined into a general expression for the determination of the bending weight.

$$\text{bending weight} = K_b\left(\frac{n}{f_b}\right)\left(\frac{W}{S}\right)\times$$

$$\left(\frac{TR + 3}{TR + 1}\right)(AR)(S)^2\left[\frac{\log(t_r/t_t)}{t_r - t_t}\right] \quad (16)$$

Similar to K_s of the shear weight equation, K_b is a proportionality factor that is determined from a previous similar design.

Skin Weight

The skin weight was found to vary linearly with the gross wing area from many statistical studies of similar types of airplanes. The skin weight includes all covering such as the main skin, tip skin, door skins, and panel joint skins. Also included with the skin weight are such items as trailing edge strips, gussets and reinforcements in the skin, rivets, nuts, and bolts that are used in final installation.

This investigation showed that the skin weight could be reliably estimated on the basis of the gross wing area. Therefore, a general equation of the following form, may be used for future estimates:

$$\text{skin weight} = K_3S$$

where K_3 is a constant of proportionality determined from many previous designs of the same type and purpose. These factors must be properly compiled and easily available for new design estimates. Actually, K_3 is the average weight per square foot of gross wing area of numerous designs.

Rib Weight

The rib weight shall be considered to be the material resisting the direct compression of the air loads on the wing. Many equations have been developed for estimating the weight of the wing ribs, but each method involved many values that were difficult to evaluate properly. The writer has found that it is more advantageous to resort to statistical data for estimating the weight of ribs. A plot was made of the variation of rib weight per square foot of gross wing area as ordinate and the gross wing area as abscissa, as shown in Fig. 10. The curve indicates that the rib weight of the class of airplanes studied is a function of the square of the gross wing area and may be expressed as follows:

$$\text{rib weight} = K_4(S)^2$$

(*Continued on page 37*)

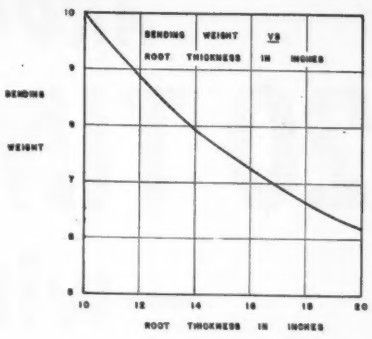


Fig. 8.

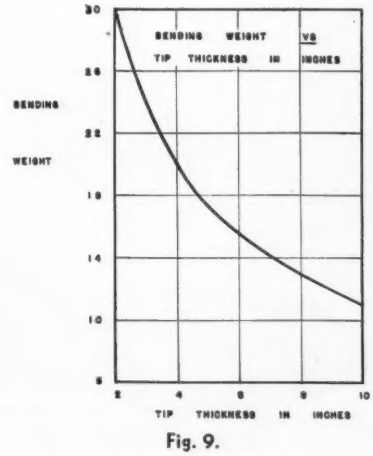


Fig. 9.

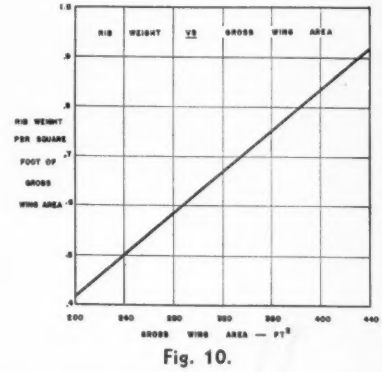
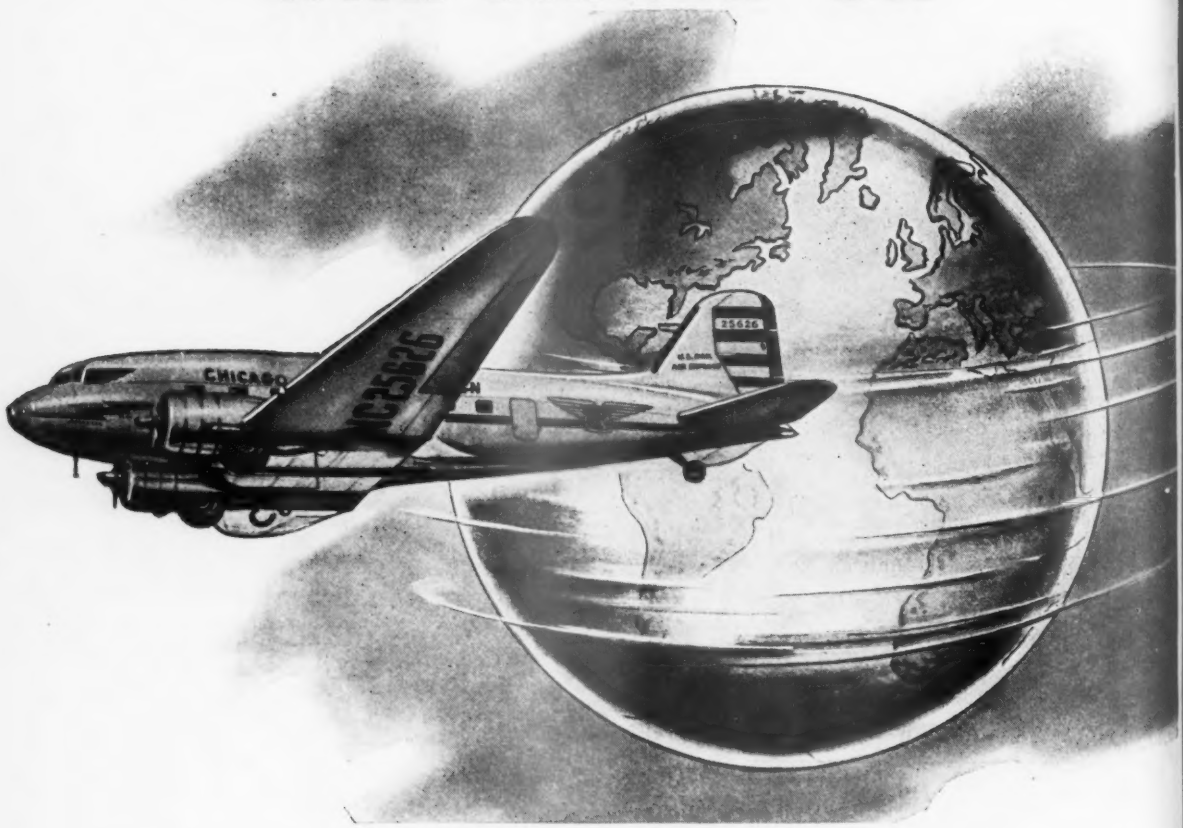


Fig. 10.

AROUND THE WORLD
20 TIMES MONTHLY
—with Sinclair Oil



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In this operation over the Valley Level Route, from Detroit and Chicago to Houston and New Orleans, the Dixieliners use Sinclair Pennsylvania Aircraft Oil—have used this lubricant exclusively for the past 10 years. It is a contributing factor to the safe, dependable, economic operation which has won outstanding recognition for Chicago and Southern's Maintenance and Engineering Divisions.

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The air we fly in

MAN AND THE EARTH'S ATMOSPHERE

The earth's atmosphere is, at present and probably will be for many years, the most important element in the science of flight. Yet this atmosphere, which supports all present day aircraft and is absolutely necessary to human life, is only meagerly understood.

Until a few years ago, the atmosphere's characteristics were unimportant to all but a few scientists. Today, the rapid strides of air transportation have caused the earth's atmosphere to affect the lives of millions of people either directly or indirectly. The tide of the present war has been largely influenced by atmospheric air battles.

In the era to follow, a knowledge of the atmosphere's characteristics is essential to air transportation as well as to weather prediction, radio communications, and the understanding of phenomena that occur in everyday life on this earth.

ATMOSPHERE'S PRESSURE AND TEMPERATURE

To aid in the understanding of the atmosphere, the earth may be visualized as a ball which is surrounded by three gaseous blankets. The weight of these three blankets is not negligible. A one-foot square column of air extending from sea level to the top of the earth's atmosphere weighs approximately one ton. These blankets of air are pulled to the earth's surface by the earth's gravity. Since air is easily compressed, it is natural that the weight of the outer blankets compresses the air so that it has the greatest pressure and weight at sea level. At greater distances from the earth's surface there is less and less weight of the air blankets acting and the pressure and weight of air becomes smaller.

Under normal conditions the heat absorbed by the earth and its lower atmosphere from the sun's radiation causes the temperature at sea level to be greater than the temperature at higher altitudes. Normally, the temperature decreases steadily with increasing height until an altitude is reached beyond which it remains essentially constant. This altitude determines the upper limit of the first blanket, and the lower limit of the second blanket which are called, respectively, the troposphere and stratosphere.

TROPOSPHERE

The height of the troposphere varies from about five miles at the poles to about ten miles at the equator. Within this first blanket is concentrated about 8/10th of the weight of the earth's atmosphere. The air in the troposphere is composed almost entirely of a mixture of oxygen and nitrogen.

STRATOSPHERE

Man's direct measurements of temperature and pressure extend upwards through the troposphere to less than half-way through the stratosphere. The upper limit of the stratosphere "blanket" is about 50 miles high.

IONOSPHERE

Even less is known about the third "blanket", the ionosphere, except that within this layer many electrical phenomena exist. The invisible Kennelly-Heaviside or "E" layer and the visible electrical displays such as the Auro Borealis are known to exist but are not yet clearly understood. In short, man, who lives at the bottom of the oceanic sea of air, knows very little about what takes place near its surface.

As aviators have ventured farther from the earth's surface they have required a greater knowledge about the air in which they fly. They quickly discovered that the weather disturbances such as thunder storms, fog, snow, and rain do not exist in the stratosphere. It was also found that, in order for humans to fly at these extreme altitudes, oxygen must be carried along and certain pressures must be maintained in the airplane cabin. A few of the other interesting factors which restrict flight of extreme altitudes are noted on the Atmosphere Chart.

THE EARTH'S WINDS

The winds aloft are as important to the pilot as the trade winds were to the old clippership skippers. The earth's wind pattern is caused by the unequal distribution on the earth's surface of the heat which is absorbed from the sun. The air over the warmer areas of the earth rises and is replaced by an inrush of air from the colder regions. This continuous circulation of air is altered by the earth's rotation towards the east about its polar axis.

SOURCES OF INFORMATION

Since direct measurements have been made of the earth's atmospheric characteristics to an altitude of only 25 miles, scientists have used indirect means to determine or predict these characteristics above that point. The composition of the stratosphere and ionosphere has been determined by analyzing the spectrum of the light from aurora displays. Each gas has particular color bands on the spectrum and by observing the spectra from the auroras, the gas can be identified.

By measuring the "reflection" of sound waves from the sky it has been inferred that the temperature must increase rapidly at altitudes greater than 20 miles. The rare appearance of noctilucent clouds at altitudes of about 50 miles plus the deduction, by some scientists, that these clouds must be formed of ice particles indicates low temperatures. Since the air is so rare at these altitudes, however, temperature does not have the same meaning as it does on the earth's surface.

The data which are presented on the Atmospheric Chart represent the best information available at the present time and have been gathered from many authorities. As more and more information is obtained these data may have to be modified and extended.

One potential source of direct measurement of atmospheric characteristics at extremely high altitudes is the sounding rocket. Balloons are definitely restricted as to their maximum altitude since they rely on the weight of the surrounding air to support them.

A CHALLENGE TO SCIENTIFIC RESEARCH

For our present knowledge of the air we fly in we are greatly indebted to the painstaking and sometimes unrecognized research of many scientific institutions. As man ventures outside of the air realm in which we fly at present, he must rely entirely on the knowledge of scientists if he hopes to return in safety. Air transportation's desire to learn more about the composition and characteristics of the earth's upper atmosphere opens a vast field of scientific research. The development of the rocket has supplied the scientist with a new tool with which he can investigate the upper atmosphere. It is hoped that now the scientist will be able to supply the aeronautical engineers with a reliable and complete knowledge of the atmosphere beyond which man-carrying vehicles have flown so that he, in turn, may design aircraft to extend the realm of "The Air We Fly In" to "The Atmosphere We Fly In" and, one day, "The Universe We Fly In".

CHARACTERISTICS OF T

SUMMARIZED FROM INFO MA

Prepared by
DOUGLAS AIRCRAFT COMPANY, INC.
El Segundo Engineering Department

PERCENTAGE COMPOSITION OF EARTH'S ATMOSPHERE BY VOLUME

Nitrogen	77.77
Oxygen	20.86
Water Vapor	.41
Argon	.93
Carbon Dioxide	.03
Hydrogen	.00005

Composition practically constant with altitude up to 30 miles, except for water vapor.

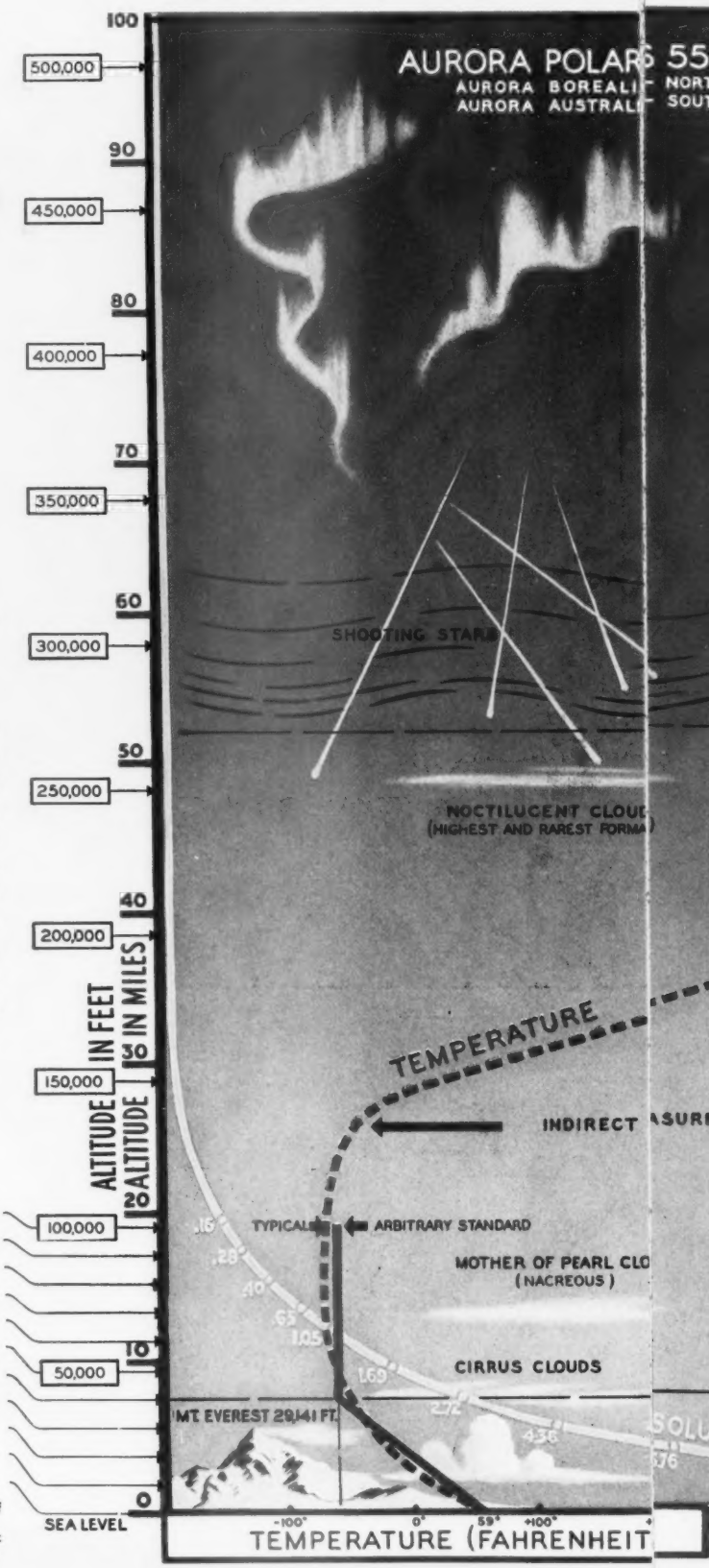
CHARACTERISTICS OF UPPER ATMOSPHERE UNDER MOST PROBABLE CONDITIONS

Altitude in Feet	Altitude in Miles	Weight of Air in Lbs. per Cubic Foot	Mean Free Path in Inches	Molecules Per Cubic Inch
500,000	94.6	....	370.	$43. \times 10^{11}$
450,000	85.2	....	65.	$25. \times 10^{12}$
400,000	75.8	....	12.	$15. \times 10^{13}$
350,000	66.3	0.2×10^{-8}	1.9	$84. \times 10^{13}$
300,000	56.8	2.6×10^{-7}	0.3	$48. \times 10^{14}$
250,000	47.4	*2.9×10^{-6}	5.8×10^{-2}	$27. \times 10^{15}$
200,000	37.9	1.6×10^{-5}	1.0×10^{-2}	$16. \times 10^{16}$
150,000	28.4	9.5×10^{-5}	1.7×10^{-3}	$96. \times 10^{16}$
100,000	18.9	.00107	2.7×10^{-4}	$62. \times 10^{17}$
50,000	9.5	.0116	3.6×10^{-5}	$47. \times 10^{18}$
0	0.0	.0765	†3.5×10^{-6}	‡$44. \times 10^{19}$

* $2.9 \times 10^{-6} = 2.9$ pounds per million cubic feet.
† $3.5 \times 10^{-6} = 3\frac{1}{2}$ millionths of an inch between molecular collisions.
‡ $44 \times 10^{19} = 440{,}000{,}000{,}000{,}000{,}000{,}000$ molecules per cubic inch.

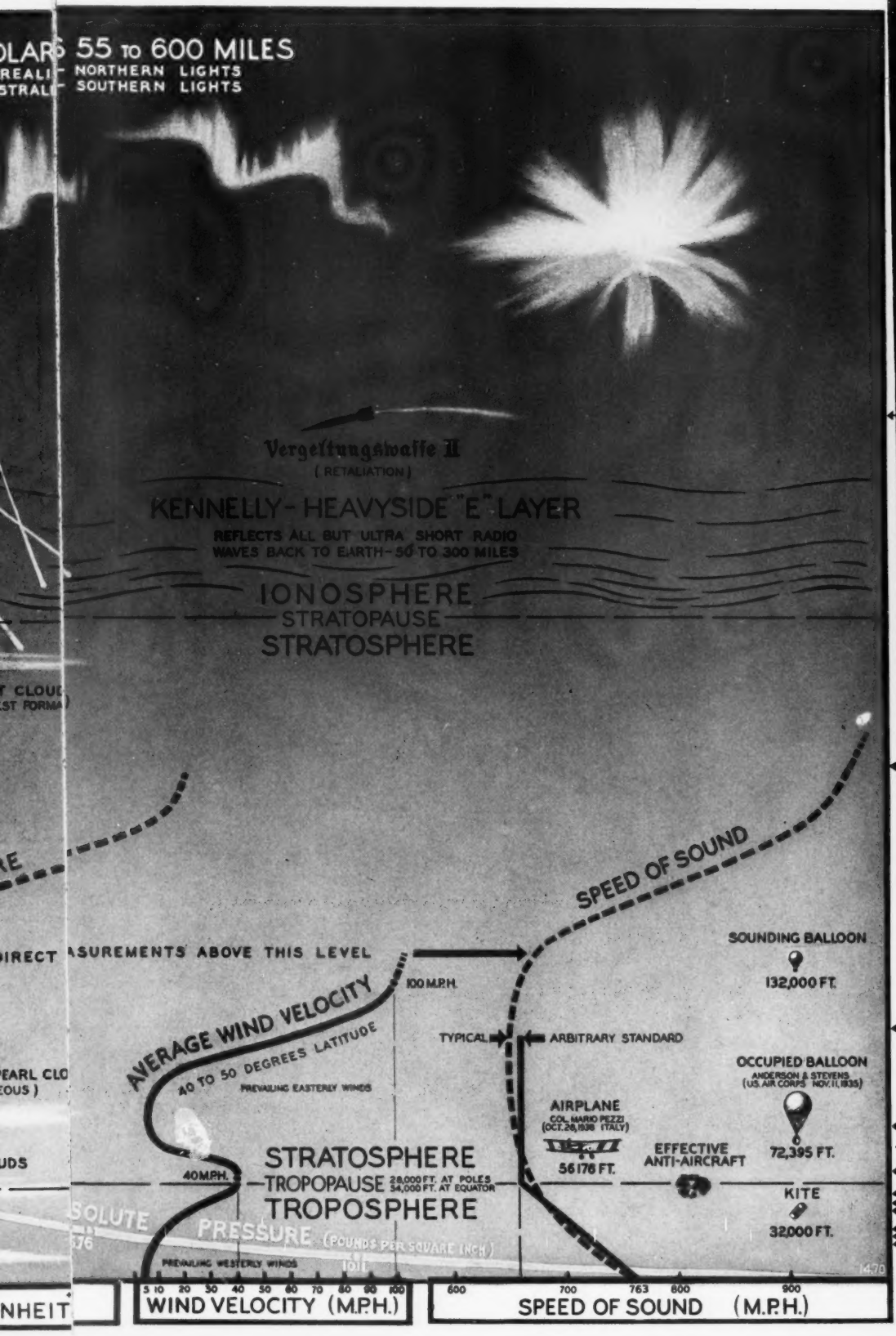
ARBITRARY STANDARD ATMOSPHERE FOR 45 DEGREES LATITUDE

Altitude in Feet	Speed of Sound (M.P.H.)	Ratio of Altitude to Sea Level Densities	Pressure (Lbs. per Square Inch)	F° Temperature	C° Temperature	Weight of Air (Lbs. per Cubic Foot)
100,000	664	.014	.16	−67°	−55°	.0011
90,000	664	.023	.28	−67°	−55°	.0017
80,000	664	.036	.40	−67°	−55°	.0028
70,000	664	.058	.65	−67°	−55°	.0044
60,000	664	.094	1.05	−67°	−55°	.0072
50,000	664	.152	1.69	−67°	−55°	.0116
40,000	664	.245	2.72	−67°	−55°	.0187
30,000	680	.374	4.36	−48°	−44°	.0286
20,000	708	.533	6.76	−12°	−25°	.0408
10,000	736	.738	10.11	+23°	−5°	.0565
0	763	1.000	14.70	+59°	+15°	.0765



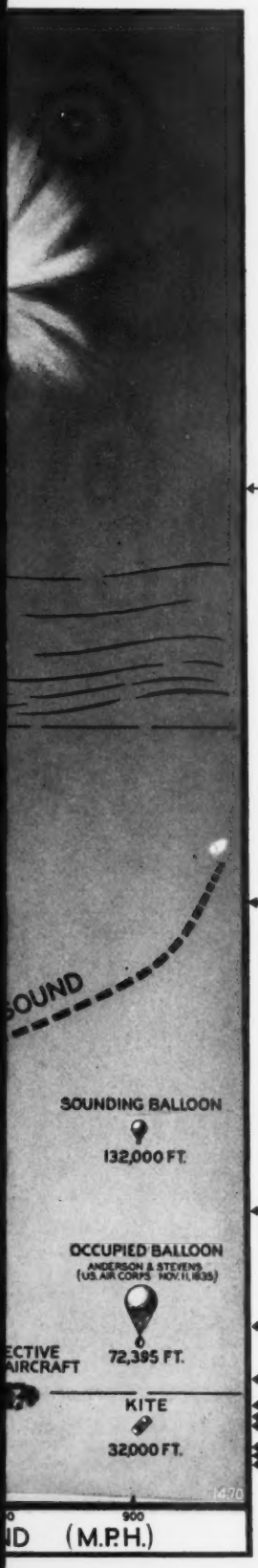
F THE EARTH'S ATMOS

NFO RMATION AVAILABLE IN 1944



MOSPHERE

WIND PATTERN OF THE EARTH



German V2 rocket bombs attain this altitude during flight, approximately 360,000 feet. (Reported to have attained an altitude of 160 miles in experimental vertical flight.)

Sound waves not propagated above this altitude due to increased distance between molecules.

Twilight limit. First magnitude stars are visible directly overhead when sun sets. 210,000 feet.

Maximum ozone concentration (one part ozone to 100,000 parts atmosphere.) 106,000 feet.

Blood boils at body temperature. 98.6° Fahrenheit. 63,000 feet.

100 per cent oxygen needed for sustenance of life. Exact altitude depends on individual and exposure. 40,000 to 45,000 feet.

Breathing pure oxygen equivalent to breathing sea level air. 33,000 feet.

Gasoline boils at normal temperature, —65° Fahrenheit. 32,000 feet.

Sky appears purple above this point. 30,000 feet.

Candle no longer burns. 21,000 feet.

Highest community of human beings Andes Mts., South America. 18,000 feet.

Oxygen required for sea level dwellers to live. Altitude depends on physical condition and duration of stay. 15,000 to 20,000 feet.

DOUGLAS EQUIPPED AIRLINES: Alaska Airlines, All American Aviation, American Airlines, American Export Airlines, Braniff Airways, Chicago & Southern Air Lines, Colonial Airlines, Continental Air Lines, Delta Air Lines, Eastern Air Lines, Hawaiian Airlines, Inland Air Lines, Mid-Continent Airlines, National Airlines, Northeast Airlines, Northwest Airlines, Pan American Airways, Panagra (Pan American-Grace Airways), Peck & Rice Airways, Pennsylvania-Central Airlines, Transcontinental & Western Air, United Air Lines, Western Air Lines. Plus 32 Foreign Airlines.

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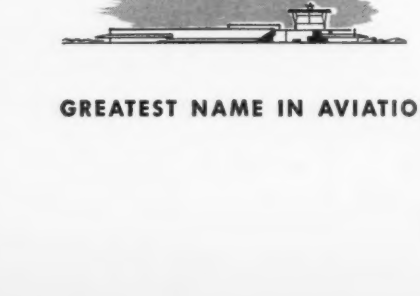
...IN WAR OR PEACE



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GREATEST NAME IN AVIATION

DOUGLAS DC-6

Sister Ship of the Famous C-54 Combat Air Transport

(*Continued from page 31*)

The coefficient, K_4, is the slope of the curve in Fig. 10. The values for the curve are taken from many similar previous designs of the same type of airplane. Careful consideration must be given to the extension of the expression beyond the class of airplanes studied to radical or unconventional design requirements.

Provisions

The provisional term will account for the wing mutilations, flaps and ailerons, landing gear, wheel pocket, gun provisions and other special features of design that are incorporated. The weight estimates for these items must be based on a compiled list of similar items on previous airplanes. A structural investigation may be performed to estimate preliminary sizes from which a weight estimate may be made. Careful judgment must be exercised in applying these provisional weight item factors.

Total Wing Weight Expression

Combining the separate terms into a grand total will produce the following general formula for estimating the weight of a new wing:

$$\text{wing weight} = K_a\left(\frac{n}{f_a}\right)\left(\frac{W}{S}\right)\times \left(\frac{TR+2}{TR+1}\right)(AR)^{1/2}(S)^{1/2} + K_b\left(\frac{n}{f_b}\right)\times \left(\frac{W}{S}\right)\left(\frac{TR+3}{TR+1}\right)(AR)(S^2)\times \left[\frac{\log (t_r/t_t)}{t_r - t_t}\right] + K_3S + K_4S + \text{provisions} \quad (17)$$

EMPIRICAL VERIFICATION

To verify the expression, the weight breakdowns of three airplanes were investigated. The necessary constants for the expression were established for one of the designs. These constants were then applied to estimate the wing weight of the other two designs. The estimated weights when compared with the actual weights were within the allowable tolerances of weight estimation.

APPLICATION

The expression as derived has considered the shear and bending material separately in order to derive an expression that is based on structural considerations. This necessitates the determination of the shear and bending coefficients from a previous similar design. The writer is of the opinion that these data may be compiled for future designs. However, this is not in agreement with the present AN Detail Weight Statement which includes the shear and bending material as one item —namely, the beam weight. Variations of the general expression may be made to suit the practice of the individual company. The shear and bending terms of the expression may be combined into one term so that data from past designs may be compiled on the basis of the total beam weight.

In order to apply the general wing weight expression in the most advantageous and satisfactory manner, it is necessary to systematically compile the required constants on a reference chart. This chart should indicate the model; the type of construction used; and the values of K_a, K_b, K_3, and K_4. Values for the provisions should be listed according to the function performed by each. With these data easily available and maintained up to date, a rapid and reasonably accurate wing weight estimate may be made for a new design for which the wing geometry is established. The effect of all the factors on the various components of the wing may be studied and evaluated in order to select the best practical value for each variable. Since the constants include peculiarities of design that are typical for each company, it is useless to list them here. Each company must compile its own data with respect to the factors mentioned. When selecting the coefficients to be used for a new wing estimate, a careful study must be made of the old and new designs to be certain that large discrepancies will not arise. In the hands of an experienced weight estimator the expression given above can be usefully applied.

Research and the Army Air Forces

(*Continued from page 11*)

that 90 min. after a nation decides to wage war bombs may be falling on any city of its choosing in the world. No spot on the globe is now more than 60 air hours away from another. Within a few short years that time will be reduced to 10 hours or less.

New and accurately controlled transoceanic weapons will be an actuality within the comparatively near future; therefore, our whole way of thinking must be revised. The nation with yesterday's concept of defense will lose tomorrow's war. America must be alert to the developments of science that they may not be turned to our destruction while we sleep.

In the light of experience and the recent phenomenal strides in technological advancement, our country can be safe from attack only by maintaining such a preponderance of strength in the air that no enemy will dare to strike the first blow. We can ensure this preponderance of strength by aggressively following a farsighted and long-range program of research. We cannot hope, as did the Germans, for the sudden development of a superweapon to save our country. Success comes through a logical step-by-step development from one stage to another. The research of today, therefore, is our insurance for tomorrow's safety.

Changes of Address

To facilitate the prompt receipt of copies of the JOURNAL and REVIEW, members and subscribers are requested to give the editorial offices 30 days' notice of any change of address.

Notices should be sent directly to the Institute of the Aeronautical Sciences, 1505 RCA Building West, 30 Rockefeller Plaza, New York 20, N.Y.

Air Technical Service Command Photo

Group photograph of Institute members, guests, and Army officers assembled for the tours of Wright Field and Freeman Field on September 14 and 15. (1) W. H. Dudley, (2) Bennett H. Horchler, (3) C. W. Meyers, (4) W. W. Cowgill, (5) Alan Binnie, (6) Lester D. Gardner, (7) Major Gen. Hugh J. Knerr, (8) Charles H. Colvin, (9) Hall L. Hibbard, (10) J. G. Vincent, (11) Gunne Lowkrantz, (12) Melville K. Weill, (13) Russell De Young, (14) L. A. Hyland, (15) R. C. Sylvander, (16) J. L. Reynolds, (17) C. L. Johnson, (18) Conrad F. Nagel, Jr., (19) Richard Mock, (20) P. B. Taylor, (21) G. M. Giannini, (22) Herman T. Kraft, (23) George A. Vaughn, Jr., (24) D. S. Bixler, (25) James S. Pedler, (26) G. A. Hyland, (27) B. N. Ashton, (28) W. D. Kennedy, (29) John C. Mathes, (30) John Victory, (31) Robert L. Earle, (32) L. P. Sharples, (33) Roger Wolfe Kahn, (34) Robert C. Gross, (35) Heyliger Church, (36) J. C. Wheeler, (37) S. H. MacArthur, (38) Hugh L. Dryden, (39) Walter H. Beech, (40) M. G. Hamilton, (42) Burdette S. Wright, (43) C. M. Williams, (44) A. T. Murray, (45) Robert Insley, (46) C. J. Brukner, (47) A. Berger, (48) Robert R. Dexter, (49) Karl Arnstein, (50) W. Wallace Kellett, (51) C. F. Codrington, (52) F. T. Harrington, (53) I. M. Laddon, (54) W. J. Blanchard, (55) Forest S. Burtch, (56) Michael Watter, (57) C. D. Geer, (58) S. L. Gabel, (59) Harry E. Blythe, (60) R. T. Goodwin, (61) A. T. Gregory, (62) A. J. Thieblot, (63) N. B. Moore, (64) Harry Woodhead, (65) Earle M. Scott, (66) Fred E. Weick, (67) J. Carlton Ward, Jr., (68) J. T. Hartson, (69) Earl D. Osborn, (70) R. H. Prewitt, (71) Sherman M. Fairchild, (72) Major Ryan. George T. Christopher and Ernest R. Breech were present at the events but are not shown in the photograph.

Institute News

Institute Members Visit Wright and Freeman Fields as Guests of Air Technical Service Command

At the special invitation of the Air Technical Service Command, a group of 70 members of the Institute visited Wright Field and Freeman Field on September 14 and 15 for an organized tour and inspection of the A.T.S.C. facilities and operations.

The group assembled at the Dayton Biltmore Hotel in Dayton at 8:30 a.m., September 14, and proceeded to the headquarters of the A.T.S.C., where Major Gen. Hugh J. Knerr, Commanding General of the Air Technical Service Command, gave a brief address of welcome. Brig. Gen. Lawrence C. Craigie, Chief of the Engineering Division of the A.T.S.C., reviewed the highlights of the Command's developments during 1945.

Upon arrival at Patterson Field a demonstration was given of the Brodie Pick-Up, a method for bringing an airplane to the ground within a limited distance, utilizing a flexible braking cable by which the airplane is caught while in flight a short distance above the ground, suspended somewhat in the manner of a monorail car, decelerated, and lowered to the ground. It was used in small jungle clearances and elsewhere under conditions that did not permit the building of a regular landing strip or airfield. An OQ target demonstration followed, showing how target aircraft are operated.

After luncheon at the Officers' Club, the members were divided into three groups, and each group in rotation visited the Equipment Laboratory, the Wind Tunnels, the Aero Medical Laboratory, the Radio and Radar Laboratory, and the Armament Laboratory.

At 5:00 p.m. the group returned to the Officers' Club for a brief period of relaxation, and at 6:30 they assembled for dinner.

At the dinner, Charles H. Colvin, President of the Institute, presided, and addresses were given by Major Gen. B. W. Chidlaw, Deputy Commanding General, Engineering (T-3), and by Brig. Gen. Lawrence C. Craigie. Orville Wright attended the dinner as Guest of Honor.

At 8:30 a.m., September 15, the group boarded airplanes for a flight to Freeman Field at Seymour, Ind.

Freeman Field was activated by Gen. H. H. Arnold in June, 1945, to serve as an installation for collecting and evaluating captured enemy aircraft and equipment. The basic purposes of the field include the receiving, reconditioning, testing, and evaluating of all enemy aircraft with a view to incorporating in our aircraft and equipment the latest techniques and inventions discovered and used by our enemies, and to obtain for the Field at least one specimen of all types of enemy aircraft and equipment. In addition, Freeman Field will collect, for historical purposes, at least one aircraft of each type used by the United States during and since the First World War.

At a luncheon at the Officers' Club at Freeman Field, talks were given by Col. Dorney and Lt. Col. Belvin about the captured enemy equipment. The group then proceeded to a detailed examination of enemy aircraft on the flight line. These included the following types: Ju 290, He 111, Me 410, Hs 129, Ju 88, Macchi 202, Me 108, FW 190, Ju 388, Me 262, Ar 234, He 219, Me 109G, Dubloff 243, Flettner 282, Do 335, and Ta 152.

Trained technical personnel were assigned to each plane to answer any questions. In addition to the airplanes, other examples of captured material were inspected in the display rooms at the Field. At 5:00 p.m. the group took off for the return flight to Wright Field.

A complete list of those who made the visit follows: Karl Arnstein, Vice-President—Engineering, Goodyear Aircraft Corporation; B. N. Ashton, President, Electrol, Incorporated; Walter H. Beech, President, Beech Aircraft Corporation; A. Berger, President, Associated Foundries & Manufacturers, Inc.; Alan Binnie, Assistant General Manager, Kollsman Instrument Division of Square D Company; D. S. Bixler, Assistant Manager in Charge of Aviation Sales, Sinclair Refining Company; W. J. Blanchard, General Manager, Aeroproducts Division of General Motors Corporation; Harry E. Blythe, Vice-President and General Manager, Goodyear Aircraft Corporation; Ernest R. Breech, President, Bendix Aviation Corporation; C. J. Brukner, President, The Waco Aircraft Company; Forest S. Burtch, Manager of Sales, Aircord Division, John A. Roebling's Sons Company; G. T. Christopher, President and General Manager, Packard Motor Car Company; Heyliger Church, Vice-President, The Weatherhead Company; C. F. Codrington, Assistant Manager, Blower and Compressor Department, Allis-Chalmers Manufacturing Company; Charles H. Colvin, President, Institute of the Aeronautical Sciences; W. W. Cowgill, Director War Products Division, United States Rubber Company; Russell De Young, Vice-President, Goodyear Aircraft Corporation; Robert R. Dexter, Secretary, Institute of the Aeronautical Sciences; Hugh L. Dryden, Chief, Mechanics & Sound Division, National Bureau of Standards; W. H. Dudley, Pacific Coast Executive, Institute of the Aeronautical Sciences; Robert L. Earle, Vice-President, Propeller Division, Curtiss-Wright Corporation; Sherman M. Fairchild, Chairman of the Board, Fairchild Engine & Airplane Corporation; S. L. Gabel, General Manager, Superior Tube Company; Lester D. Gardner, Chairman of the Council, Institute of the Aeronautical Sciences; C. D. Geer, Vice-President, Instrument Division, Thomas A. Edison, Inc.; G. M. Giannini, President, G. M. Giannini & Company, Inc.; R. T. Goodwin, Manager, Aviation Division, Shell Oil Company; A. T. Gregory, Chief Engineer, Ranger Aircraft Engines Division, Fairchild Engine & Airplane Corporation; Robert C. Gross, Manager, Commercial Research, Solar Aircraft Company; F. T. Harrington, Vice-President, Vickers, Inc.; J. T. Hartson, President, The Glenn L. Martin-Nebraska Company; Hall L. Hibbard, Vice-President and Chief Engineer, Lockheed Aircraft Corporation; Bennett H. Horchler, Executive Vice-President, Institute of the Aeronautical Sciences; G. A. Hyland, Manager, Application Department, Aviation Gas Turbine Division, Westinghouse Electric Corporation; L. A. Hyland, Executive Engineer, Bendix Aviation Corporation; Robert Insley, Engineer, Continental Motors Corporation; C. L. Johnson, Chief Research Engineer, Lockheed Aircraft Corporation; Roger Wolfe Kahn, Test Pilot and Manager of Service Department, Grumman Aircraft Engineering Corporation; W. Wallace Kellett, President, Kellett Aircraft Corporation; W. D. Kennedy, Vice-President and General Manager, Wright Aeronautical Corporation; Herman T. Kraft, Experimental Engineer, General Tire & Rubber Company; I. M. Laddon, Executive Vice-President, Consolidated Vultee Aircraft Corporation; Gunne Lowkrantz, Vice-President, Link Aviation Devices,

Berger, (58) Robert R. Dexter, (57) S. L. Gabel, (59) Harry E. Blythe, (60) R. T. Goodwin, (61) A. T. Gregory, (62) A. J. Thiebot, (63) N. B. Moore, (64) Michael Watter, (57) C. D. Geer, (58) S. L. Gabel, (59) Harry E. Blythe, (60) R. T. Goodwin, (61) A. T. Gregory, (62) A. J. Thiebot, (63) N. B. Moore, (64) Scott, (66) Fred E. Weick, (67) J. Carlton Ward, Jr., (68) J. T. Hartson, (69) Earl D. Osborn, (70) R. H. Prewitt, (71) Sherman M. Fairchild, (72) Major Ryan. George T. Christopher and Ernest R. Breech were present at the events but are not shown in the photograph.

THE NEW KOLLSMAN FOUR-ENGINE SYNCHROSCOPE enables the pilot or flight engineer to bring all engines quickly to the same r.p.m. for the uniform power output required by economy and correct operating procedures. Designed at the request of AAF to cover military needs, these synchroscopes also have their application to transport aircraft, where they contribute to passenger comfort as well as to proper operation of the plane. The accuracy and dependability of these synchroscopes, together with their simplicity of operation, are characteristic of all Kollsman Aircraft Instruments.

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Bendix Establishes New International Division

Bendix Aviation Corporation, a Corporate Member of the Institute, has formed a new division, Bendix International, to coordinate the company's comprehensive foreign trade program.

With the exception of the United States and Canada, the new division will handle, throughout the world, the products of the 17 divisions of the corporation. It has established headquarters at the corporation's New York office, 30 Rockefeller Plaza, and will maintain a staff of engineering, sales, and service personnel which will be expanded here and abroad as world conditions permit.

The company's activities will be developed abroad through three main channels, as determined by the situations in the various foreign countries. They will include export sale of products that the company manufactures here, manufacture by Bendix of its products abroad, and licensing of foreign manufacturers to manufacture under Bendix patents abroad.

Gifts to the Aeronautical Archives

An escape kit of the type used by fighter and bomber crews over Europe, including nylon maps and a large tag for identification of fliers forced down over Russia, was received from Col. Carl Norcross. Models of Army Air Forces type AT-11 airplane and Beechcraft model 18-S were received from the Beech Aircraft Corporation through the courtesy of Walter H. Beech.

Lt. W. Donald Thomas, U.S. Navy, gave 160 domestic and foreign air-transport labels. Lt. H. Schoenfeld of the Navy gave 26 foreign and domestic air-transport labels and gave assistance in the classification of the Archives collection of baggage labels and stickers. New stickers of Mid-Continent Airlines, Inc., were received from that company through the courtesy of W. R. Moreland.

An air-mail pilot's mate wings, in use from 1930 to 1935, and a future pilot wings, were received from United Air Lines, Inc. Three insignia of Mid-Continent Airlines, Inc., and four insignia of Hanford Airlines were received through the courtesy of J. C. Collins. Six of its insignia were received from Transcontinental & Western Air, Inc.

A volume of pamphlets on *Detail Aircraft Structural Analysis* was sent by The Glenn L. Martin Company, through F. D. Jewett. Seven aeronautical books and photographs were added to his previous generous gifts by Dr. Alexander Klemin. Mrs. Bella C. Landauer added *Youthful Sports*, Philadelphia, 1802, to the rare children's aeronautica, which are part of her previous generous gifts. A book, *Milestones*, was received from Miles Aircraft, Ltd. Miss Agnes Brewster gave *Antwerpen onder V1 & V2*, written in Dutch, English, and French and published in Antwerp in 1945.

The Douglas Aircraft Company, Inc., sent 30 wall charts on the C-54 transport airplane. The Civil Aeronautics Board sent a file of its *Report of Formal Economic Proceedings*. Issues of its periodicals, *Contact* and *Air-Tact*, were received from Michigan Wing 63 of the Civil Air Patrol. A file of *MAC Service Letter* was received from the Mutual Aircraft Conference. A bound volume of *New Horizons* for 1944–1945 was sent by Pan American Airways, Inc., through the courtesy of William Van Dusen. The Escola Tecnica de Aviação of the Ministério da Aeronáutica of Brazil sent a file of its periodical, *Papel Péga-Mosca*. Issues of *The Propeller* were given by the Air Service Veterans' Association. The British Air Commission in Washington added 17 *British Air Ministry Translations* to the large number previously given.

Documents relating to applications before the Civil Aeronautics Board for new air routes and extensions of existing routes were received from Pan American Airways, Inc.; Southern Airways, Inc.; Transcontinental & Western Air, Inc.; and United Air Lines, Inc.

Additional gifts were received from the Aluminum Company of America, Inc.; Beech Aircraft Corporation; Boeing Aircraft Company; Booth Manufacturing Corporation; C. G. Grey; the Engineering Experiment Station of Washington University; the U.S. Air Technical Service Command, Army Air Forces; Board on Geographic Names; Bureau of Labor Statistics; Civil Aeronautics Administration; Securities and Exchange Commission; and the House and Senate document rooms.

Sections and Branches

Detroit Section

The following have been elected officers of the Detroit Section for the 1945–1946 season: Chairman, Arthur A. Locke; Vice-Chairman, Franklin A. Dobson; Secretary, Frank Lewand; Treasurer, Edgar Lesher.

The Advisory Council selected for the coming season is composed of the following: Peter Altman, Carl Bachle, Ralph N. DuBois, John Fontaine, Arnold M. Kuethe, George H. Tweney, and John C. Squiers.

Phoenix Section

Following a dinner held at the Arizona Room of the Adams Hotel in Phoenix, a meeting of the Phoenix Section took place on August 17. Snead Parker, Chairman of the Admissions Committee, gave a report on the new members and recent applicants. Four guests were introduced by the Chairman. The appointment of a Materials and Process Committee was announced by the Chairman, and Mr. Cass, a member of the new committee, gave a résumé of the O.G.R.D. report of the hot-dimpling of 75S-T aluminum alloy.

Richard D. Searles, Traffic Manager of Transcontinental & Western Air, Inc., spoke on the subject "Aviation and the Postwar World." The speaker gave particular emphasis to the operation of private air lines on world routes. He related many of the experiences of T.W.A. in ocean flying. The theory of pressure-pattern flying for long routes was presented and explained by sketches made on the blackboard. A question-and-answer period followed the lecture, during which Mr. Searles discussed a broad range of technical subjects.

Two films, furnished by the Bell Aircraft Corporation, were shown—*Cannon on Wings* and *B-29 over Dixie*. The projector and operator were provided by AiResearch Manufacturing Company.

Aeronautical University

At a business meeting on August 6 the following new officers of the Student Branch were elected: Chairman, Raymond B. Williams; Vice-Chairman,

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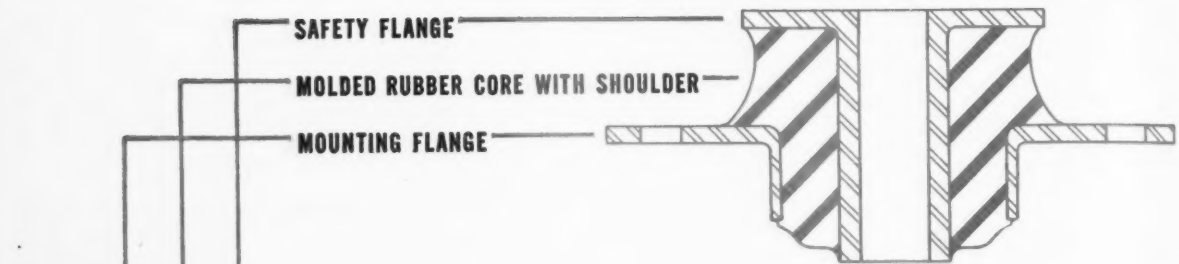

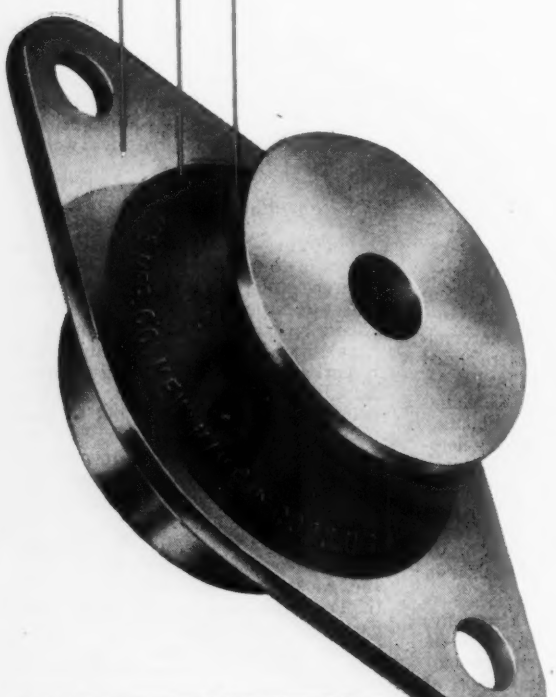

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To assure peak isolator performance, MB engineers are prepared to work with you on your new plans for engine suspensions . . . or make a detailed study of your existing mechanisms . . . and submit highly qualified recommendations, and data that'll save you much time and effort. We invite your inquiries.

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Paul J. Riley; Treasurer, Isidro G. Buitron; Secretary, Erwin A. Bania; Faculty Adviser, K. L. Burroughs. Dates for future meetings were unanimously agreed upon, and rules and regulations were explained and discussed.

At a business meeting on August 29, a motion-picture committee was nominated, as well as a committee to secure lectures. There was also a discussion of the films available in the library of the Institute.

University of Colorado

On June 8 the senior members of the Student Branch made a tour of the Continental Denver Modification Center. During this trip the students and faculty members were shown many of the intricate mechanisms used in the B-29. They were allowed to go through the airplane and inspect it fully. The motion-picture film *Birth of the B-29* was shown.

Iowa State College

A combined technical and business meeting of the Student Branch took place on August 6. Professor Lester Kelso, Faculty Adviser, gave a talk on "Cycloidal Propulsion."

University of Kansas

At a business meeting on August 23, the first of the present semester, the following officers were elected: Chairman, Leroy Coleman; Vice-Chairman, Roy McVey; Secretary-Treasurer, Robert White.

Massachusetts Institute of Technology

Technical and business sessions were held on August 2 by the M.I.T. Branch. The report of the Secretary-Treasurer was given, and plans were made for a membership campaign for the current term.

At the technical session Dr. Sanford A. Moss, Consulting Engineer of the Supercharger Engineering Division of General Electric Company, gave a talk on "Gas Turbines and Turbosuperchargers," illustrated by slides provided by the speaker. A short informal discussion was held with Dr. Moss after his talk with regard to the future applications of turbosuperchargers and similar mechanisms.

University of Michigan

On July 11 Prof. R. H. Sherlock, of the Department of Civil Engineering of the University of Michigan, gave a talk on "Unions and Engineers." At the same meeting the officers presented their program plans for future meetings. Numerous suggestions were made, one of which concerned the possibility of obtaining private flying lessons for members. This was tabled for future consideration. Chairman Scudder outlined the activities of the Institute and its position at the University and nationally.

The meeting on July 18 was given to the election of an engineering-council representative, for which Fred Brinkel was selected. Plans for future social functions were made.

A technical meeting on July 25 was addressed by A. R. Lambert, Chief Project Engineer of Stinson Division of Consolidated Vultee Aircraft Corporation. He spoke on the "Practical Side of Engineering." Further consideration was given to plans for social and technical gatherings.

At a meeting on August 8, Asst. Prof. F. R. Steinbacher, of the Department of Aeronautical Engineering of the University of Michigan, spoke on "Let's Consider the Nontechnical Side of Engineering." Professor Steinbacher was elected Faculty Adviser in place of Professor Schetzer, who had been elected at a previous meeting but found it necessary to decline because of the pressure of outside work.

University of Minnesota

At the August 22 meeting of the University of Minnesota Branch, Ray C. Posz was elected Vice-Chairman in place of David Laurie, who has been called into the armed forces.

Willis Gille, Chief Engineer of the Minneapolis Honeywell Regulator Company, spoke on "Aeronautics in Germany." He described his experiences during a recent trip to Germany and showed slides and films he had taken while there.

University of Oklahoma

The University of Oklahoma Branch held a meeting on July 9 at which the following officers were elected for the new semester: Chairman, H. D. Nolan; Vice-Chairman, A. E. Petrik; Secretary-Treasurer, T. M. Gayle. Three Army films about aircraft structures were shown.

At a meeting on August 14 the films *Fighters in the Sky* and *Yucatan* were shown. The minutes of the preceding meeting were read, films were discussed, and incidental business was transacted.

Purdue University

An organization meeting for the July-November term was held on July 18. The following officers were elected: Chairman, Frank Nichols; Vice-Chairman, Dick Ludwick; Secretary, W. L. MacReynolds; Treasurer, Alan Dale.

Professor Bruhn explained the functions of the Institute to new members and suggested contacts and activities for the semester.

At a meeting on August 8 three Government films were shown.

Spartan College of Aeronautics

The Spartan College Branch held a meeting on August 2 at which plans were made for speakers for future meetings. It was decided to invite the Production Engineer of the Spartan Aircraft Company to speak at a future meeting.

On August 30 the members gave consideration to the social activities of the student body, and it was decided to hold a social gathering at the home of D. T. Emmick.

University of Texas

The following officers of the Student Branch were elected at a meeting on August 1: Chairman, Barney Chaudoin; Vice-Chairman, Hutt Lancaster; Secretary, Marilyn Broom; Treasurer, Gail Bradford. Plans were made for obtaining a motion picture or speaker for a future meeting.

Virginia Polytechnic Institute

On August 28 the following officers of the Student Branch were elected: Chairman, F. B. Sutton; Vice-Chairman, G. W. Watts; Secretary, R. A. Booth; Treasurer, S. Bramow; Faculty Adviser, L. Z. Seltzer.

News of Members

Louis Bruchiss has been appointed Editor of the Engines Section of the publication *Aerosphere*.

Harry A. Burke, whose name has been legally changed from Harry A. Berkowitz, has been promoted to the rank of First Lieutenant in the U.S. Army Air Forces.

Millford E. Collins has been advanced to the rank of Lieutenant Commander in the U.S. Naval Reserve.

John E. Creiger, Jr., was recently appointed Sales-Service Manager for Commonwealth Aircraft, Incorporated.

Donald E. Diller has been transferred to the Nashville Division of Consolidated Vultee Aircraft Corporation but is temporarily on "loan" to the Stinson Division at Wayne, Mich.

Andrew G. Haley, former President of Aerojet Engineering Corporation, has resumed the practice of law at Washington.

Joel T. Henry is now Production Engineer at All State Engineering Company.

Richard S. Huested has been named Administrative Assistant to William D. Kennedy, Vice-President and General Manager of Wright Aeronautical Corporation.

Comdr. John J. Ide, U.S.N.R., formerly assigned to the Bureau of Aeronautics of the Navy Department, has been appointed Assistant Naval Attaché for Air at the American Embassy in London.

Ludwig G. Lederer has been advanced to the Office of Director of Personnel Administration of Pennsylvania-Central Airlines.

George F. McLaughlin has been named Director of Technical Publications of the McLaughlin-Carr Associates.

Howard J. Rosan has been appointed Senior Structures Engineer in the Research Laboratories of the Airplane Division of the Curtiss-Wright Corporation.

Reinhardt M. Rosenberg has been transferred to the Nashville Division of Consolidated Vultee Aircraft Corporation as Design Specialist.

Darrell R. Shreve has joined the faculty of the University of Tulsa as Associate Professor of Mathematics.

William G. Street, formerly Chief Flight Test Engineer of Consolidated Vultee

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Aircraft Corporation, has joined The Glenn L. Martin Company in the same capacity.

Fred W. Sturm is now Assistant Chief Engineer of Winner Manufacturing Company.

Phillip B. Taylor, former Vice-President of Wright Aeronautical Corporation, has been retained by Pan American World Airways in the capacity of Consulting Engineer.

Alexander E. Ulmann has returned to his former activities as Export Consultant and Export Manager for various American aviation interests.

Edward P. Warner, Vice-Chairman of the Civil Aeronautics Board, has been unanimously elected by the Interim Council of the Provisional International Civil Aviation Organization to be the first President of that organization. Dr. Warner has announced that he would resign his office at the Civil Aeronautics Board, but up to the time of going to press the resignation has not been confirmed.

Members Elected

The following applicants for membership or applicants for change of previous grades have been admitted since the publication of the list in the last issue of the REVIEW.

Transferred to Associate Fellow Grade

Allen, James Ross, M.S.; Captain, U.S. Navy.

Burstein, Adolph, B.S. in Ae.E.; Project Engineer, Consolidated Vultee Aircraft Corp.

Dobrow, Harry Paul, B.M.E.; Consulting and Project Engineer, Office of the Chief of Ordnance (Detroit).

Gage, William Caleb, Zone Manager, Allison Div., General Motors Corp.

Gauvain, William E., Ae.E.; Chief Engineer of Engineering and Experimental Dept., Richmond Naval Air Station, U.S. Navy.

Greg, Wsevolode A., Aerodynamics Engineer, Consolidated Vultee Aircraft Corp.

Hoffman, Samuel Kurtz, B.S. in M.E.; Chief Engineer, Lycoming Div., The Aviation Corp.

Hyatt, Abraham, B.S. in Ae.E.; 1st Lt., U.S. Marine Corps, Head of Design Research Section of Aviation, Bureau of Aeronautics.

Ivanoff, Victor Apollon, M.S.; Aeronautical Engineer P-4, Langley Mem. Aero. Lab., N.A.C.A.

Klenke, William Henry, Jr., Lt. Col., Engineering and Operations Officer, U.S. Marine Corps.

Kosko, Eryk, Asst. Prof., École Polytechnique de Montreal (Canada).

Lyon, Thoburn Cassady, Chief, Aeronautical Chart Branch, C & G S, Dept. of Commerce.

Maloney, Joseph Francis, B.S. in M.E.; Asst. Project Engineer, The Glenn L. Martin Co.

Markle, Edwin Gillian, Designer "B," Douglas Aircraft Co., Inc.

Morrison, Robert Laurance, B. of Applied Science; Project Engineer, Fleet Aircraft Ltd. (Canada).

Nowakowski, Zygmunt John, Production Manager, Canadian Wooden Aircraft Ltd. (Canada).

Pack, Mendel Nathan, M.S. in Ae.E.; Dept. Head, Structures, Curtiss-Wright Corp.

Phillips, Michael Joseph, Ae.E.; Lt. Comdr., U.S.N.R.

Savage, Charles Francis, B.S. in E.E.; Design Engineer in charge of Aeronautical Instrument Engineering Div., General Electric Co.

Elected to MEMBER Grade

Delgado, Humberto Da Silva, Director General of Portuguese Civil Aviation, Portuguese Government (Portugal).

Friedman, Harold Emanuel, B.S. in M.E.; Mechanical Engineer, Aircraft Engine Research Lab., N.A.C.A.

Graham, James Augustus, Field Service Engineer, Consolidated Vultee Aircraft Corp.

Gravitt, Bruce Benson, B.S. in E.E.; Electrical Engineer, General Electric Co.

Hauptman, Frederic F., Project Engineer, Kollsman Instrument Div., Square D Company.

Marx, Harry J., Comdr., U.S. Navy, Head of Hydraulics and Pneumatics Section, Engineering Div., Bureau of Aeronautics.

Noville, George Otto, Technical Advisor, Asiatic Petroleum Co. (Ecuador).

Robinson, Bennett Robert, B.S. in Ae.E.; Staff Engineer, Pan American Airways, Inc.

Ross, William Clifford, M.E.; 1st Lt., ORC, Inspection Officer, U.S. Army Air Forces.

Sagert, Harold Theodore, Sales Manager, Aviation Div., Lear, Inc.

Schneider, John Henry, B.Ae.E.; Capt., Tactical Engineering and Maintenance Officer, U.S. Army Air Forces.

Smith, Wesley Warren, B.S. in M.E.; Design Engineer, AiResearch Manufacturing Co.

Wielkoszewski, Wladyslaw, Engineer at Design Office, Canadair Ltd. (Canada).

Zeisloft, Harry Chamberlain, B.S. in M.E.; Project Engineer, Aeronca Aircraft Corp.

Transferred to MEMBER Grade

Boice, Walter John, B.S. in Ae.E.; Design Engineer, Stinson Div., Consolidated Vultee Aircraft Corp.

Burroughs, Richard Hansford, Jr., B.S. in M.E.; Chief Experimental Pilot, Chance Vought Aircraft Div., United Aircraft Corp.

Cole, Charles Willard, B.Ae.E.; Capt., U.S. Army Air Forces.

Crocker, Albert Rudolph, M.S.; Asst. Chief Engineer, Propeller Div., Engineering & Research Corp.

Frick, Jack E., B.Ae.E.; Flight Test Engineer, Lockheed Aircraft Corp.

Frost, Richard Hart, B.Ae.E.; Project Engineer and Test Pilot, Bell Aircraft Corp.

Haarman, Donald William, B.S.; Asst. to Mr. W. A. Reichel, Kearfott Engineering Co.

Horwath, Albert S., B.Ae.E.; Project Engineer, Brewster Aeronautical Corp.

Katzenberger, Edward Frederick, B.M.E.; Project Engineer, Sikorsky Aircraft Div., United Aircraft Corp.

Leich, Harvey Adam, B.Ae.E.; Major, U.S. Marine Corps.

Lothrop, William G., B.S. in Ae.E.; Structural Coordinator, Fisher Body Aircraft Div., General Motors Corp.

Love, Charles C., Jr., B.S. in Ae.E.; Engineer, Aerodynamics, Boeing Aircraft Corp.

Mayer, Norman Jules, Flight Test Group, Research & Development Dept., Goodyear Aircraft Corp.

Paine, Joseph Partridge, S.B. in Ae.E.; Sr. Flight Test Engineer, The Glenn L. Martin Co.

Power, James Thomas, B.M.E.; Design Engineer-B, Lockheed Aircraft Corp.

Sanders, Robert, B.S. in Ae.E.; Lt. Comdr., V-1 Division Officer, U.S. Navy.

Schramm, Herbert Theador, Asst. Chief Tool Engineer, Administrative, Allentown Div., Consolidated Vultee Aircraft Corp.

Soraghan, Joseph Cahill, Jr., Group Structural Engineer, Fairchild Aircraft Div., Fairchild Engine & Airplane Corp.

Soult, Stanley Stephenson, Associate Arts Degree, 2nd Lt., U.S. Army Air Forces.

Spiegel, Herman Bert, Machine and Tool Designer, H. L. Yoh Company.

Wilson, Donald Pastorious, B.S. in M.E.; Head of VSB-VTB Radio and Electrical Installation Section, Bureau of Aeronautics, U.S. Navy Dept.

Wold, Robert Palmer, B. of Bus. Admin., B.Ae.E.; Structures Officer, Fleet Air West Coast, Lt. (j.g.), U.S.N.R.

Elected to Industrial Member Grade

Carr, John French, B.Sc.; Liaison Engineer A., Douglas Aircraft Co., Inc.

Demi, Ernest Llewellyn, Aviation Representative, Standard Oil Co. of Pa.

McElrath, Robert Harold, Manager, Aviation Equipment Dept., The Ohio Chemical & Manufacturing Co.

Paveley, Herbert Grahame, B.S.; Group Leader, Canadair Limited (Canada).

Ross, Roland Albert, B.Ae.E.; Plant Supt., Timm Aircraft Corp.

Elected to Technical Member Grade

Craves, Roderick, Stress Engineer, Nash-Kelvinator Corp.

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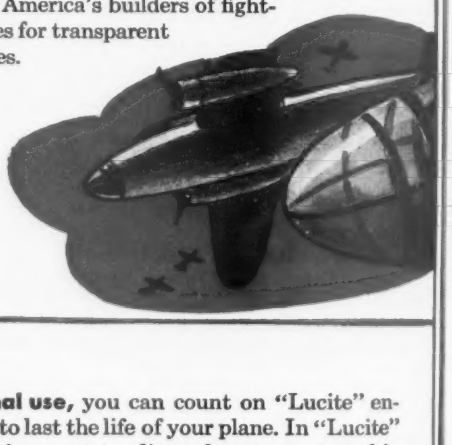

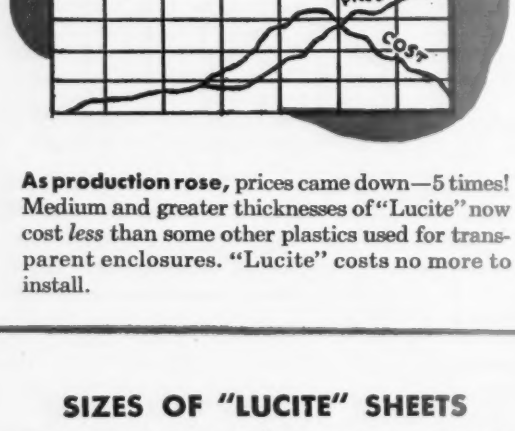

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Fletcher, Floyd Richard, Sr. Draftsman, La Salle Design Co.

Frank, Arnold J., B.S. in Ae.E.; Flight Test Analyst, Consolidated Vultee Aircraft Corp.

Hu, Chang-Shou, B.S. in Ae.E.; Engineer Trainee, McDonnell Aircraft Corp.

Kelly, Allan William, B. of Textile Engineering; Jr. Aeronautical Engineer, Bureau of Aeronautics, U.S. Navy Dept.

Koch, Paul Wesley, Jr., Liaison Engineer, Cessna Aircraft Co.

Melancon, James Lloyd, Coordinator, Consolidated Vultee Aircraft Corp.

Murnane, Daniel Francis, Sr. Aircraft Engineer, Bechtel-McCone Corp.

Norrison, Daniel A., Aeronautical Draftsman, Ae. Section, Baldonnel Aerodrome, Defence Forces (Eire).

Ouimet, Pierre, G.E.; Stress Analyst, Canadair Limited (Canada).

Transferred from Student to Technical Member

Ackerman, William Knox, B.S.; Design Engineer, Jarvis Mfg. Co.

Boswell, Clay C., Jr., B.Ae.E.; Research Asst., University of Minnesota.

Bram, Robert Murray, Aviation Designer & Aeronautical Engineer, The Glenn L. Martin Co.

Bretoi, Remus Nicolas, B.Ae.E.

Bruning, William Henry, B.Ae.E.; Apprentice Engineer, Grumman Aircraft Engineering Corp.

Burns, John Joseph, Jr., B.S.; Design Engineer, Bell Aircraft Corp.

Caswell, Robert Leroy, B.Ae.E.; Structures Officer, U.S.N.R.

Cocuzzo, Francis, B.Ae.E.; Aero. Engineer, Grumman Aircraft Engineering Corp.

Dalton, Robert Leon, B.Ae.E.; Ensign, U.S.N.R.

Davenport, Edward Lounsbury, Jr., B.Ae.E.; U.S. Navy.

DeCaro, Charles James, B.S. in Ae.E.; Flight Test Engineer, Goodyear Aircraft Co.

Dickey, Thomas Atherton, M.S. in Aeronautics; Test Engineer, U.S. Navy.

Dixon, Thomas Francis, M.S. in Ae.E.; Lt., U.S.N.R.

Douglass, Glenn Maynard, B.Ae.E.; Aviation Student, U.S. Navy.

Eddy, Elwin Herklas, M.S. in Ae.E.; Col., U.S. Army Air Forces.

Edwards, Franklin Sproles, M.S. in Aeronautics; Asst. Prof., Mississippi State College.

Fritz, Raymond Joseph, B.Ae.E.; Research Analyst, Lockheed Aircraft Corp.

Goebel, Thomas Parker, M.S.; Aerodynamicist, North American Aviation, Inc.

Goetsch, Edward Joseph, Jr., B.M.E.; U.S. Navy.

Grabowski, George Joseph, Designer, The Glenn L. Martin Co.

Gray, Robert Merle, B.Ae.E.; U.S. Navy.

I. A. S.

Special Meetings Schedule

1945

October 25, 1945
WASHINGTON MEETING

December 17, 1945
WRIGHT BROTHERS LECTURE, Washington, D.C.

January, 1946
FOURTEENTH ANNUAL MEETING, New York

The Officers and Council of the Institute invite participation in the Technical Sessions of the Meetings of the Institute.

The Meetings Committee will consider for inclusion on the program complete papers, or outlines or summaries of proposed papers.

Information for Participants

(1) Complete papers, or outlines or summaries should be submitted in triplicate at least four months prior to the meeting at which it is proposed to present the paper. Outlines or summaries should not exceed 1,000 words.

(2) Each paper should be so planned that it may be presented within a time limit of 45 minutes.

(3) All papers submitted will be considered for publication in the **Journal of the Aeronautical Sciences** or the **Aeronautical Engineering Review.** While a paper should be planned to take only 45 minutes for presentation at a meeting, the written presentation may have a maximum length of approximately 15,000 words.

(4) All material received will be submitted to the Meetings Committee. Authors will be notified, in ample time to prepare the complete paper, whether or not their papers can be scheduled for presentation.

All correspondence should be addressed to
The Meetings Committee
Institute of the Aeronautical Sciences
1505 RCA Building West
30 Rockefeller Plaza
New York 20, N. Y.

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Greene, John Lycurgus, Midshipman, U.S. Navy.

Hamilton, Ray Waldo, B.S.; U.S. Navy.

Henzlik, William Charles, B.S.; U.S. Navy.

Hewes, Donald Edward, B.Ae.E.; Engineer, Engineering & Research Corp.

Houston, Jack Sterling, B.Ae.E.; U.S. Navy.

Howard, Claude Randall, B.M.E.; U.S. Navy.

Hruda, Richard Joseph, B.S.; Aero. Engineer, Lockheed Aircraft Corp.

Hubbard, Herbert Blood, B.Ae.E.; U.S. Navy.

Lindner, Melvin, B.Ae.E.; Engineer, Daniel Guggenheim School of Aeronautics, N.Y.U.

Luce, Robert Duncan, B.Ae.E.; U.S. Navy.

Matusow, Daniel Martin, B.Ae.E.; Aerodynamicist, Chance Vought Aircraft Div., United Aircraft Corp.

Mayster, Sidney, B.S. in M.E.; Aerodynamicist, Bell Aircraft Corp.

Millett, Merlin Lyle, Jr., B.S. in Ae.E.; U.S. Navy.

Mueller, Merle Charles, B.Ae.E.; U.S. Navy.

Olsen, Lawrence Gilbert, B.Ae.E.; Engineer, Grumman Aircraft Engineering Corp.

Pirrello, Charles Joseph, Aero. Engineer, The Glenn L. Martin Co.

Samhammer, Donald Frederick, Aero. Engineer, The Glenn L. Martin Co.

Shuman, William Henry, Jr., U.S.N.R.

Spooner, Albert Joseph, Jr., B.S.; Midshipman, U.S.N.R.

Woodhull, Roger Blake, M.S. in Ae.E.; Comdr., U.S. Navy.

Elected to Affiliate Grade

Gomez, Guillermo Gonzalez, B. in Engineering; Architect, Institute of Inter-American Affairs (Guatemala City, C.A.).

Streicher, Albert Henry, P.F.C., U.S. Army Air Forces.

Necrology

Vice Adm. John Sidney McCain, U.S.N.

Vice Adm. John Sidney McCain, U.S.N., an Honorary Member of the Institute, and commanding officer of the Second Carrier Task Force, Pacific Third Fleet (known as Task Force 38) during the closing phases of the war, died of a heart attack at his home in Coronado, Calif., on September 6. He had arrived in the United States by air on the preceding day after taking part in the Japanese surrender ceremonies on board the U.S.S. "Missouri" in Tokyo Bay. Funeral services with full military honors were conducted in Washington on September 10, and Admiral McCain's body was interred in Arlington National Cemetery.

Admiral McCain was born on August 9, 1884, in Teoc, Miss., and was educated at the University of Mississippi and the United States Naval Academy, from which he was graduated in 1906. His first assignment was to the Asiatic station. He rendered service on shore and at sea through two wars and in the intervening years, having been Engineer Officer of the cruiser U.S.S. "San Diego" on escort duty during the first World War.

In 1918 he was ordered to the Bureau of Navigation and spent alternate periods as an officer of increasing responsibilities on capital ships of the Navy and on shore duty. At the age of 51 he undertook flight training at the Naval Air Station at Pensacola, Fla., became a naval aviator, and was made commanding officer of the Fleet Air Base in the Canal Zone.

After commanding the carrier U.S.S. "Ranger," he took charge of the Naval Air Station at San Diego, and in 1941 assumed command of the Aircraft Scouting Force. During the early part of 1942 he commanded all naval aircraft in the South Pacific and was then appointed Chief of the Bureau of Aeronautics. He later became Deputy Chief of Naval Operations for Air, serving in that office until his assignment to command Task Force 38.

Personnel Opportunities

This column is for the use of individual members of the Institute seeking new connections and organizations offering employment to aeronautical specialists. Any member or organization may have requirements listed without charge by writing to the Secretary of the Institute.

WANTED

Aircraft Engineers—Immediate, permanent openings for aircraft engineers with 5 years' experience in aerodynamics, structural design, and C.A.A. airworthiness requirements with Southern California aircraft manufacturer. Air-mail qualifications and recent photo to P.O. Box 29, Burbank, Calif.

Draftsmen—Experienced in the layout and detailing of mechanical devices for industrial and aircraft products. Excellent working conditions, convenient location. Address inquiries to Simmonds Aerocessories, Inc., and Simmonds Products, 30 Rockefeller Plaza, New York, N.Y.

Detail and Layout Engineers, Stress Analysts, Aerodynamicists, and Design Engineers—For development work and production engineering work in Engineering Division. Must be citizens of the United States and have a certificate of availability. Call in person or write to Chief Administrative Engineer, Boeing Airplane Company, Wichita, Kan.

Radio, Electronic and Telephone Engineers, Electronic and Mechanical Draftsmen.—One of the largest manufacturers of a wide variety of electronic and communications equipment in the world is fully prepared and ready with an ambitious postwar program. Write to Personnel Manager, Federal Telephone & Radio Corp., 591 Broad Street, Newark, N. J.

Aeronautical Engineer—To teach Senior year subjects of aeronautical engineering course including design and stress analysis. Address inquiries to The Aeronautical University, Inc., 116 South Michigan Avenue, Chicago, Ill.

Aircraft—Chief of Structures. Eight years' experience. Write McDonnell Aircraft Corporation, St. Louis 1, Mo.

Aircraft—Chief of Weights. Five years' weight experience. Write McDonnell Aircraft Corporation, St. Louis 1, Mo.

Aerodynamicists, Stress Engineers, and Vibration Analysts. Needed for the Helicopter Division of Bell Aircraft Corp., Niagara Falls, New York. Write full details to R. A. Wolf, Chief Engineer, Helicopter Product Division.

Aeronautical Engineers—for immediate and urgent top priority work, the long-established Aeronca Aircraft Corporation seeks Project Engineers, Stress Analysts, Weight Engineers, and Layout Draftsmen. Since Aeronca's postwar plans are complete, with peacetime production in the offing, these positions offer unusual permanent opportunities for qualified men who can comply with W.M.C. requirements. Write in complete detail to Aeronca Aircraft Corporation, Box 00, Middletown, Ohio.

Aircraft Stress Engineers thoroughly familiar with the analysis of aircraft structures, aircraft controls, and all component parts for work on helicopters. Excellent opportunities for personnel interested in rotary-wing aircraft. Apply by letter, giving references, to Administrative Engineer, Kellett Aircraft Corporation, Plant #2, Lansdowne Avenue above State Road, Upper Darby, Pa.

Personnel Needed—Executive and Administrative experience in manufacture of aircraft. Positions available in several fields; Factory and

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Aircraft Engineers—Experienced aerodynamicist; layout and detailed draftsmen; structural designers; senior drawing checkers; static test engineer; stress analysts; technical illustrators; technical writer. These positions immediately available in critical war work at attractive salaries. Postwar prospects excellent. Applicants must comply with W.M.C. regulations. Address replies giving education, experience, background, age and draft status to Personnel Manager, Edo Aircraft Corporation, Terminal Building, Flushing, N.Y.

Detail and Layout Draftsmen, Stress Analysts, and Design Engineers needed for development work in the Engineering Department. Must be citizen, not employed in essential war industry, or have a certificate of availability from the U.S. Employment Service Office or the War Manpower Commission of your area. Address inquiries to Curtiss-Wright Corporation, Airplane Division, Buffalo, N.Y.; Attention: Director of Engineering.

Aerodynamicist or Flight Test Engineer—Ability to analyze flight test data on advanced high performance aircraft. Submit qualifications to McDonnell Aircraft Corporation, Ambassador Building, St. Louis 1, Mo.

Airplane Salesmen—Large established producer of personal aircraft seeking several qualified airplane salesmen with both flying and merchandising experience. Interview in New York. Address inquiries to Box 362, Institute of the Aeronautical Sciences.

Assistant Sales Manager—Large established producer of personal aircraft seeking qualified assistant sales manager. Interview in New York. Salary commensurate with ability. All replies treated confidentially. Address inquiries to Box 361, Institute of the Aeronautical Sciences.

Associate Professor of Aircraft Structures—To teach senior and graduate courses in aircraft structural theory, develop structures laboratory, and direct graduate structural research work. Practical experience necessary. Advanced degrees preferred. Permanent position. Leading State University. Location—Midwest. Address inquiries to Box 340, Institute of the Aeronautical Sciences.

Associate or Full Professor: To teach advanced courses and direct research in the Aircraft Power Plant Design field. Recent experience in turbine and jet engine design and testing necessary. Advanced degrees preferred. Permanent position, large mid-western university. Can wait six months if necessary. Address inquiries to Box 339, Institute of the Aeronautical Sciences.

Assistant or Associate Professor of Aerodynamics—Young man with Ph.D. to teach graduate courses in theoretical aerodynamics and direct theoretical and experimental research in this field. Research experience necessary. Position permanent. Mid-western State University. Address inquiries to Box 338, Institute of the Aeronautical Sciences.

Associate or Professor of Aerodynamics—To teach performance, control, stability and develop correlating flight test and flight instrumentation courses for large mid-western university. Position permanent. Practical experience necessary. Advanced degrees preferred. Address inquiries to Box 337, Institute of the Aeronautical Sciences.

Chief Engineer—To supervise an Engineering Department of 250 to 300 people working in a company doing aircraft design on prime contracts with the U.S. Navy. Applicant must have an engineering degree plus several years of background as Assistant Chief Engineer or better in an aircraft company of similar size. Must possess drive and initiative. Must be exceptionally strong on detail design. Incumbent will report to the Vice-President in Charge of Engineering. Salary between $10,000 and $13,000 per year. Address inquiries to Box 335, Institute of the Aeronautical Sciences.

Engineer—In charge of Experimental and Field Service Division of established aircraft company. Graduate engineer with good engineering background plus several years of experience as a supervisor of experimental manufacture. Applicant must be energetic with ability to perceive and follow-through problems typical of this type of manufacture. Must possess thorough knowledge of engineering and shop practices. Previous experience in the aircraft field working for a prime contractor considered absolutely essential. Salary $10,000 to $13,000 per year. Address inquiries to Box 334, Institute of the Aeronautical Sciences.

Aeronautical Cataloging Librarian. Experienced. Permanent position in New York City. Open October, 1945. Address inquiries to Box 330, Institute of the Aeronautical Sciences.

Aircraft Layout or Stress Engineer. Mid-west location. New aircraft designing. Write full particulars. Address inquiries to Box 329, Institute of the Aeronautical Sciences.

Engineer—To supervise manufacture of new airplane. Aeronautical background and heavy shop supervision experience absolutely essential. Good wages. Pleasant working conditions. Write all information in detail. Address inquiries to Box 328, Institute of the Aeronautical Sciences.

Aeronautical Engineer—With experience in structures and stress analysis and the writing of reports for submission to the Civil Aeronautics Administration. Address inquiries to Box 326, Institute of the Aeronautical Sciences.

Patent Engineer—Familiar with patent disclosures and procedures. Essential helicopter industry. Salary commensurate with experience and present earning capacity. Address inquiries to Box 322, Institute of the Aeronautical Sciences.

Electronic and Mechanical Engineers—Large radio corporation presently engaged in urgently needed war work for the armed forces needs engineering personnel in all categories. Sound peacetime future with an established leader in the field of Electronics. Located in East and mid-West. Write in detail. Address inquiries to Box 317, Institute of the Aeronautical Sciences.

Aeronautical Engineer, Chief of Structures, Stress Analysts—Excellent opportunity for qualified men with medium-sized aircraft manufacturer on postwar work. Commercial experience preferred but not necessary. Applicant must comply with W.M.C. regulations. Address inquiries to Box 309, Institute of the Aeronautical Sciences.

Stress Analysts and Aerodynamicists—Required for aircraft design work U.S. Naval Aircraft Prime Contractor. Address inquiries to Box 297, Institute of the Aeronautical Sciences.

Assistant Professor—To teach Mechanics, Strength of Materials, and Physics in a small Mid-western College. Must have Master of Science Degree, preferably in Engineering or Physics. Salary dependent on qualifications and experience. Position permanent. Address inquiries to Box 291, Institute of the Aeronautical Sciences.

Draftsmen—Four or five, wanted by large research and development organization; experienced in the layout of aircraft structural members. Four or five years' experience required; knowledge of stress analysis desired. Experience in wing or fuselage group would prove satisfactory. Address inquiries to Box 282, Institute of the Aeronautical Sciences.

Aerodynamics Engineer—Practical experience wanted by well-known long-established mid-west manufacturer to conduct technical research and market development in ventilating and air-cooling division. Attractive salary for man of ability and ambition. Address inquiries to Box 275, Institute of the Aeronautical Sciences.

Mechanical & Electronic Engineers—Large engineering firm en-

(*Continued on page 55*)

measuring thrust and torque

Hagan THRUSTORQ gives the aviation and automotive industries an entirely new method of measuring engine thrust and torque, which combines the advantages of simplicity, sensitivity, accuracy, flexibility—and low cost.

Essentially, Hagan THRUSTORQ consists of an air chamber, one face of which is a flexible diaphragm. The air chamber is connected to a source of compressed air. When force is exerted on the diaphragm, a poppet valve admits air until the pressure in the air chamber exactly balances the force on the diaphragm. When this force is reduced, air is exhausted until the pressures are again in equilibrium. The response to changes in force is practically instantaneous—every normal change is followed instantly.

When used to measure torque, the Hagan THRUSTORQ is mounted so that the torque arm of the dynamometer rests on the diaphragm. The force exerted by that arm, and hence the engine torque, is measured *by the air pressure required to balance this force.* It's just that simple.

Pressures can be registered on a manometer, or gauges may be calibrated to give readings directly in foot-pounds. Standard pressure recording devices may be employed to provide a continuous test record. Where unusually large engines require the use of several dynamometers, the THRUSTORQS may be connected so as to give an automatically totalized reading. The location of any gauge or recording device is determined *solely by convenience.*

Hagan THRUSTORQ has no intricate mechanism, nothing which is likely to get out of order, no knife edges to wear down with consequent loss of accuracy.

The flexibility of the Hagan THRUSTORQ far exceeds that of any other torque-measuring device. Once a test is started, torque at all speeds and loads can be measured without adjustments or compensations of any kind. So sensitive is this device that the same THRUSTORQ will measure the torque of a 2000 HP airplane motor or the weight of a twenty-five cent piece.

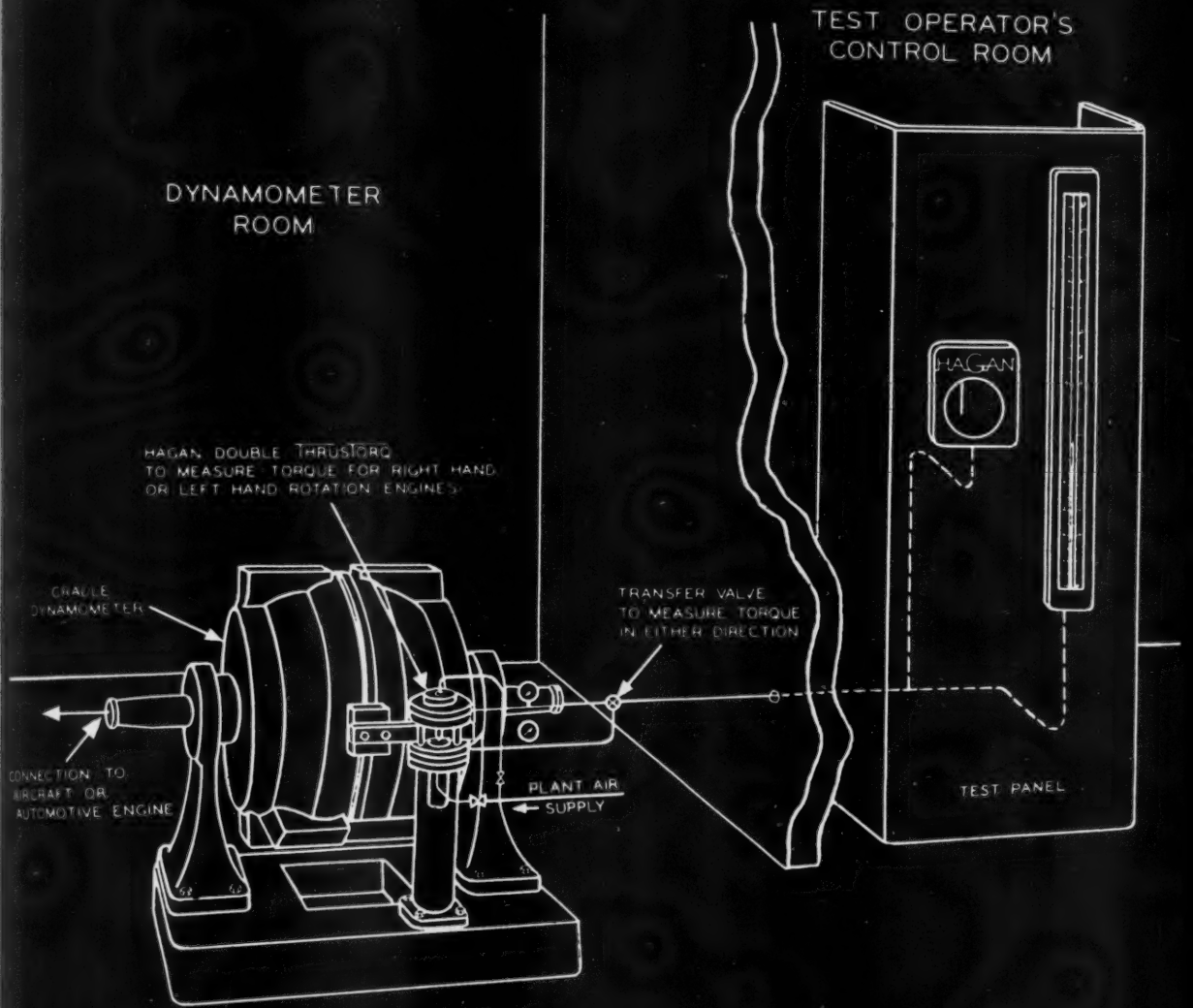
Hagan THRUSTORQS are *already in service* in major airplane and automobile engine factories. They are used not only for the measurement of torque of standard horizontal engines, but also torque of vertical helicopter engines and thrust of jet engines.

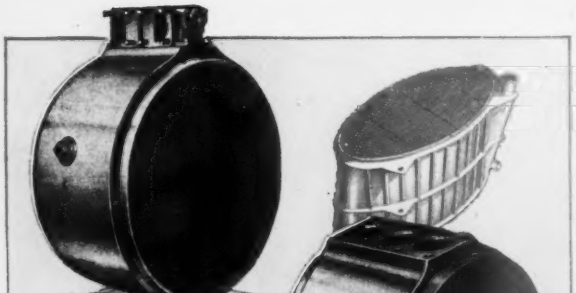
Our engineers will be glad to give you full information about Hagan THRUSTORQ in the automotive and aviation industries.

HAGAN THRUSTORQ
measuring thrust and torque *with air!*

HAGAN CORPORATION, HAGAN BUILDING, PITTSBURGH 30, PA.

with air!


TEST OPERATOR'S
CONTROL ROOM
DYNAMOMETER
ROOM
HAGAN
HAGAN DOUBLE THRUSTORQ
TO MEASURE TORQUE FOR RIGHT HAND
OR LEFT HAND ROTATION ENGINES
CRADLE
DYNAMOMETER
TRANSFER VALVE
TO MEASURE TORQUE
IN EITHER DIRECTION
CONNECTION TO
AIRCRAFT OR
AUTOMOTIVE ENGINE
PLANT AIR
SUPPLY
TEST PANEL



Value of Aluminum In Heat Exchangers Proved in Service

Where light weight as well as resistance to high temperatures and pressures are vital — as in aircraft oil coolers and coolant radiators — all-aluminum heat transfer units have demonstrated their superiority over copper units.

Brazing of aluminum in thin sections — a Clifford discovery — has already brought these advantages to designers of heat transfer units for several types of USAAF aircraft.

1. A saving of ⅔ the weight of copper in the same size and shape.
2. A high-temperature aluminum alloy bonding material with a melting point several times higher than that of the soft solder used on copper units.
3. Heat-treatable aluminum tubes, plates, shells and other parts that withstand temperatures up to 275°F. . . . much higher than the annealing point of copper.

Clifford's aluminum brazing and heat transfer unit manufacturing facilities have been devoted entirely to military aircraft requirements during the war. Now, applications in the automotive, heating, cooling and ventilating fields are being discussed. Your inquiry is invited. *Clifford Feather-Weights — Save ⅔ the weight . . . same size and shape.*

Success of Aneroid Bellows Assemblies Promises New Uses

War-tested applications of aneroid or evacuated bellows assemblies for utilizing the motion caused by changes in altitude or vacuum, point the way to new refinements in aircraft and industrial instruments.

For example, an evacuated bellows assembly — as pictured above from three angles — can be so accurately calibrated that its valve-operating motion automatically causes an oxygen regulator to supply the proper mixture of air and oxygen at any altitude.

The success of evacuated bellows assemblies depends on the accuracy of the spring rate of the bellows . . . which is determined by the uniformity of its wall thickness.

Only the hydraulic method of forming bellows . . . *a Clifford production achievement* . . . assures maximum uniformity of wall thickness. That is why Clifford Hydron Evacuated Bellows Assemblies have been so successful during the war . . . and promise so much in peace-time applications.

An outline of your problem — with sketches and data — involves no cost or obligation. Write for the facts before designs are too far advanced. *First with the facts on Hydraulically-Formed Bellows.* Clifford Manufacturing Company, 560 East First Street, Boston 27, Massachusetts.

CLIFFORD *Feather Weight*

OIL COOLERS AND COOLANT RADIATORS

HYDRAULICALLY-FORMED BELLOWS HYDRON Metal Bellows

(*Continued from page 51*)

gaged in essential work with growing backlog of postwar jobs needs engineering personnel in all categories: Designers, Layout & Detail Draftsmen, Checkers, etc. Location Manhattan. W.M.C. rules observed. Address inquiries to Box 263, Institute of the Aeronautical Sciences.

AVAILABLE

Aeronautical Engineer—S.B. in Aeronautical Engineering, Massachusetts Institute of Technology. 27 years old. Over 6 years of design and structures experience, desires position with West Coast Aircraft Manufacturer. Available immediately. Address inquiries to Box 360, Institute of the Aeronautical Sciences.

Stress Analyst and Design Engineer—B.S. in Mechanical and Aeronautical Engineering from I.I.T. Have had experience in large eastern aircraft corporation as design engineer since graduation in June. Have had much study in stress analysis in structures and intend working for masters degree. Desire position in structural design or stress analysis. Any location considered. W.M.C. compliance and draft exempt. Address inquiries to Box 359, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Ten years' experience teaching aeronautics and allied subjects. At present employed by Navy Department in aerodynamic analyses of military aircraft, including considerable work in jet propelled types. Desires a teaching position in the south or southwest by winter or spring term. Address inquiries to Box 358, Institute of the Aeronautical Sciences.

Engineering Service and Sales Representative—Engineering Degree, total of 10 years' aircraft design, accessory and sales engineering, hydraulic and control equipment experience. Extensive contacts, services, aircraft plants, industrial and marine field. Seeking position in engineering or engineering sales or as technical representative in aviation or allied field. Address inquiries to Box 357, Institute of the Aeronautical Sciences.

Aeronautical Equipment and Sales Engineer—Graduate engineer with 14 years' experience in civil and military aviation specializing in the sales and service of aircraft instruments and equipment. Recently released from active service in the Army Air Forces after 6 years devoted largely to pilot training and aircraft and equipment testing. Over 5,000 hours as pilot in military and civil aircraft. Interested in position offering executive responsibilities in the interest of sales and service within this country or abroad. Will consider any position where a broad background in aviation development, initiative, responsibility can be employed. Available for immediate employment. Excellent references. Address inquiries to Box 356, Institute of the Aeronautical Sciences.

Design Specialist—B.S.Ae.E. Ten years' experience private pilot, experimental engine testing, stress analysis, preliminary airplane design, contract administration, responsible for the design and manufacture of numerous engine installations ranging from 165 to 3,000 hp., as well as turbo and turbojets. Excellent background in coordination of production and tooling acquired in capacities of project engineer and design section manager. Widely acquainted in the industry east and west. References based upon accomplishments. Desires affiliation in responsible capacity with progressive engineering organization. Address inquiries to Box 354, Institute of the Aeronautical Sciences.

Senior Aeronautical Engineer—B.S.M.E. Eleven years' experience in selecting equipment and supervising installations for aircraft manufacturing processes, including experience in production of airplane motors. Now engaged as Assistant to the Production Superintendent of Naval Aircraft Factory, but is in a position to do consulting work as industrial engineer. Address inquiries to Box 353, Institute of the Aeronautical Sciences.

Senior Electrical Draftsman. Experienced in design of three-phase power circuits for large aircraft and similar electrical problems. Now located in Canada but is available for position in United States in aircraft electrical work. Address inquiries to Box 352, Institute of the Aeronautical Sciences.

Engineer—Pilot. Ph.D. (Thermodynamics). Experience as Research Metallurgist. Pilot and aircraft maintenance officer, two years, U.S.A.A.F. Desires position in engineering research and development with manufacturer of engines, propellers or accessories for light planes. Available immediately. Address inquiries to Box 351, Institute of the Aeronautical Sciences.

Engineer—B.S. in M.E. Age 27, married, two dependents. Seven years' varied aircraft engine experience. Past positions include Test Engineer, Supervisor of Carburetor Test Laboratory, and Assistant Chief Inspector. Desires engineering position doing experimental research or product development. East Coast preferred. No objection to traveling. Address inquiries to Box 350, Institute of the Aeronautical Sciences.

Development Engineer, A.E. graduate. Experience includes complete development and sales engineering of aeronautical and mechanical accessories and instruments. Background of light plane and military aircraft design. Private pilot. West Coast location preferred. Address inquiries to Box 349, Institute of the Aeronautical Sciences.

Aeronautical Engineer (Canadian)—Four and one-half years' experience in all types of aircraft, group leader in design modifications and technical publications. On pilot's course in the Royal Naval Air Arm from September, 1944, to V-J Day. Now on discharge schedule. Available after October 1. Desires connection with either manufacturer or airline. Willing to travel. Address inquiries to Box 348, Institute of the Aeronautical Sciences.

Engineer—M.E. Degree (1943). Worked nine months as assistant project engineer on electromechanical devices before entering the Navy. Honorably discharged after service as radio technician. Engaged as aerodynamicist since February, 1945, on jet-propelled aircraft project. Desires position in New York City where experience in electromechanics and aerodynamics can be utilized. Address inquiries to Box 347, Institute of the Aeronautical Sciences.

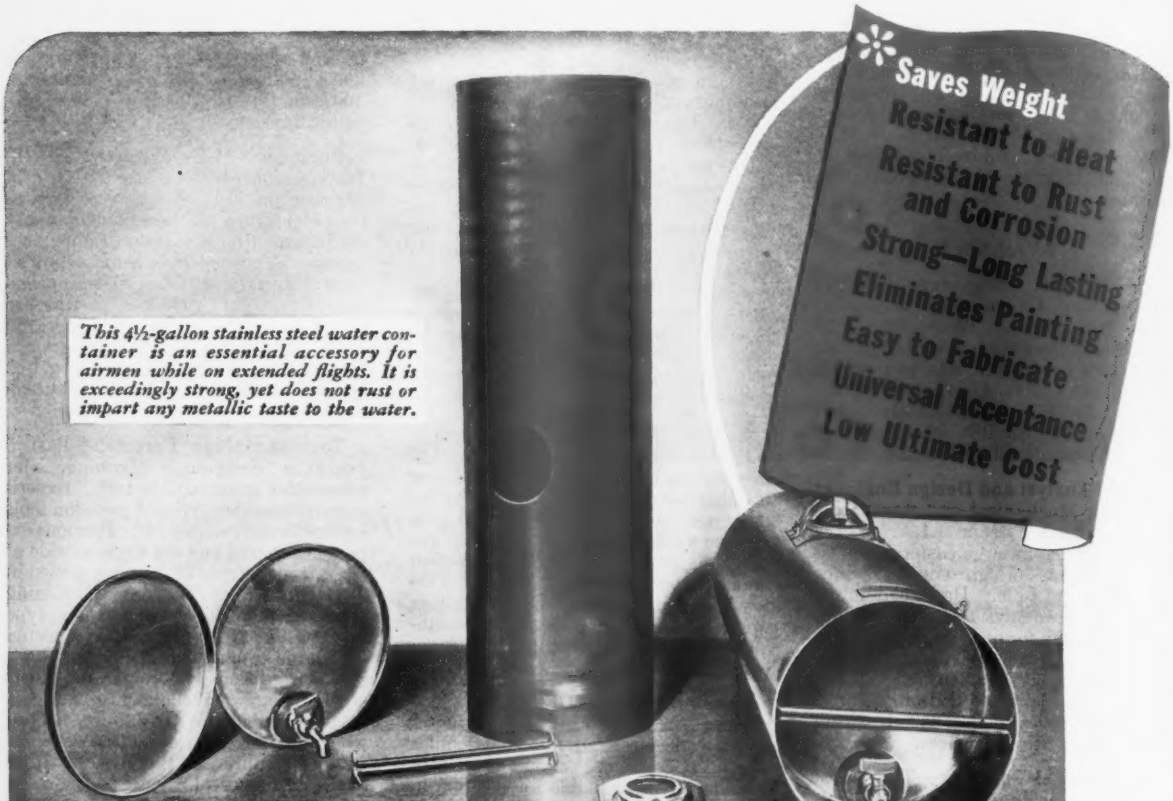
Tool and Gage Foreman—Past 5 years in designing, planning, and supervising gage manufacture. Experience covers other types of precision tools such as broaches, dies, etc. Previous experience in tool and die work outside of aircraft industry. Thoroughly versed in Tool Steel Heat Treating, Nitrioning Process, Stabilizing, Immersion type and Open Hearth Furnaces. Connected with large aircraft manufacturing plant. Seeking position as Foreman or Assistant Foreman with reliable firm, not necessarily aircraft. Willing to locate anywhere in United States and Possessions. Address inquiries to Box 346, Institute of the Aeronautical Sciences.

Registered Professional Aeronautical Engineer—Has successful consulting practice; would like to represent a responsible aviation corporation or air-line company in the Detroit and lower Michigan area. Graduate degrees from two universities; 8 years' experience as consultant, engineer, executive and professional man. Services could cover all fields such as engineering and sales contacts, technical and professional representative, etc. Permanent appointment with modest monthly retainer fee desired. Address inquiries to Box 345, Institute of the Aeronautical Sciences.

Senior Aerodynamicist—Over 20 years' experience in aeronautics. Excellent theoretical background. Now Research Engineer with big company. Desires permanent responsible position, preferably as Consulting or Research Engineer. Address inquiries to Box 344, Institute of the Aeronautical Sciences.

Engineer—Four years' experience as Layout Draftsman on Wood and Aluminum-Alloy Construction. Desires position as Project Group Leader. Location in Eastern States preferred. Address inquiries to Box 343, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.S.M.E., University of Colorado; M.S. Aero. Eng., Massachusetts Institute of Technology. Five years' experience: 4 years with A.T.S.C., Engineering Division, Wright Field in Flutter, Aircraft Dynamic Load Measurement, and general development of mechanical and



This 4½-gallon stainless steel water container is an essential accessory for airmen while on extended flights. It is exceedingly strong, yet does not rust or impart any metallic taste to the water.

Enduro Pays IN MANY WAYS

Republic ENDURO Stainless Steel—the metal with an extremely high strength-to-weight ratio—is the ideal material for many aircraft parts and accessories.

Because of this high strength-to-weight ratio, ENDURO can be used in thin, light-weight sections which afford a higher safety factor than many other materials of greater thickness.

Moreover, because ENDURO provides exceptional corrosion-resistance, no allowance is necessary to provide for later loss of strength in vital structural members due to corrosion.

For complete details about these and other profitable advantages of incorporating Republic ENDURO Stainless Steel in aircraft and aircraft accessory design, write directly to:

REPUBLIC STEEL CORPORATION
Alloy Steel Division • Massillon, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, New York

Republic
ENDURO STAINLESS STEEL
Reg. U. S. Pat. Off.

Other Republic Products include Carbon, Alloy and "Quality" Steels—Pipe, Sheets, Strip, Plates, Bars, Wire, Pig Iron, Bolts and Nuts, Tubing

electronic instruments and recording equipment. Desires position in instrument research and development and flight test engineering. Address inquiries to Box 342, Institute of the Aeronautical Sciences.

Helicopter Chief of Structures—Two years' Chief of Structures, Sikorsky Aircraft, formerly Chief Stress Analyst other leading rotowing manufacturer. Licensed professional engineer, New York, New Jersey, Connecticut, Pennsylvania. Twenty years' structural designing background. Address inquiries to Box 341, Institute of the Aeronautical Sciences.

Engineer—B.Ae.E.; M.S. in M.E.; Ph.D.; Aeronautics major. Holds pilot's license and C.A.A. ratings to teach all phases of ground school. Prefers position in industry but will consider a university position with research and consulting possibilities. Location on west coast preferred but not a limitation. Address inquiries to Box 336, Institute of the Aeronautical Sciences.

Research and Development Engineer, B.S. in E.E.; M.S. in Ae.E. Three years' experience in propeller stress analysis, previous experience in electronic equipment and some experience in control mechanism design. W.M.C. compliance. Highest references. Must do essential work. Address inquiries to Box 333, Institute of the Aeronautical Sciences.

Graduate Aeronautical Engineer—Bachelor and Master of Aeronautical Engineering degrees from N.Y.U. Two and one-half years' engineering in aircraft manufacturing and 2½ years' engineering in air-line maintenance and operation. Recently completed engineering and economic studies on major postwar aircraft for air-line operation. Will receive Masters in Commerce and Finance in 2 years. Draft exempt and release available. Excellent references. Address inquiries to Box 332, Institute of the Aeronautical Sciences.

Aeronautical Engineering Student. Three years of college. Desires full-time engineering work, preferably in New York. Address inquiries to Box 331, Institute of the Aeronautical Sciences.

Service Engineer, B.S. in M.E.—Commercial pilot, licensed mechanic and navigator, also foreign licenses and international aviator's license. Fifteen years' aviation experience ranging from small flying service to foremost U.S. and foreign factories. Recent duties include: installation engineer, test pilot, service engineering, publications manager, asst. service manager of large engine factory. Spent last 2 years exploring sales possibilities in all Latin-American countries. Speaks French, Spanish, Dutch, German and understands Portuguese. Sees no further scope for improvement after 6 years with present employer and is interested in position with a future in progressive organization where his experience and abilities can be fully utilized. Address inquiries to Box 327, Institute of the Aeronautical Sciences.

Executive-Engineer-Test Pilot—World War II veteran with two years' recent supervisory experience in design and flight-testing for large commercial aviation corporation. Seven years of college engineering followed by five years of active duty as commanding officer of aircraft advanced-base, maintenance, repair, experimental, and operational units. Active experimental test pilot in service and during last two years in commercial aviation. Combat and test experience in over 50 different types of single and multi-engine land- and seaplanes. Recent experience in gas turbines and jet propulsion. War veteran status precludes any difficulty in leaving present position. Airline engineering and operation or manufacturer's flight research and design most desirable. Address inquiries to Box 324, Institute of the Aeronautical Sciences.

Airport Engineer—Five and a half years' experience as airport engineer. Responsible for site selection, layout, design, and inspection during construction of over 40 airports in eastern states. Experience also includes speaking before municipal governing bodies and local service clubs on frequent occasions. Registered professional engineer and have a student pilot's license, recently soloed. Desire connection as airport consultant with engineering company or airline. Particularly adapted to liaison work and promotion. Any location considered. W.M.C. compliance. Address inquiries to Box 323, Institute of the Aeronautical Sciences.

Stress Analyst, Design and Development Engineer—B.S. in Aeronautical Engineering and Engineering Mechanics, four years' experience in research, design, development and stress analysis pursuits with prominent aircraft concerns. One year on analysis and static test of pure monocoque wing. Two years as supervisor of group engaged in design and stress analysis of bombardment type airplane. One year with entire structural responsibility for extensive structural modification for large patrol type aircraft. Desires position with responsibility for structural design or stress analysis. Address inquiries to Box 321, Institute of the Aeronautical Sciences.

Aeronautical Engineer and Test Pilot with design, experimental engineering and flight experience desires suitable position doing development work or experimental engineering and/or flight testing. Available immediately. Address inquiries to Box 312, Institute of the Aeronautical Sciences.

Research Analyst and Technical Writer. Twenty-one years' experience, including Patent Law, Medicine, Aeronautics, and Internal Combustion Engineer, Liaison and Production Planning, including LPG. Several years in Engineering Department of Aircraft Manufacturer. Familiar with setting up technical records and systems. West Coast preferred. Address inquiries to Box 310, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Pilot—Graduate engineer over 15 years' experience in design, research, and manufacturing; eight years as experimental test pilot; eighteen years' flying experience. Desires position with company offering postwar future combining engineering and flying. Past employment includes several years as consulting engineer and chief engineer with large company. No objection to traveling. Address inquiries to Box 307, Institute of the Aeronautical Sciences.

Sales and Service Engineering Executive, fifteen years' experience in airplane, engine and accessory design, service and sales, air-line maintenance engineering. Seeking position offering executive responsibilities organizing and directing sales and service activities or air-line maintenance engineering organization, either in this country or Latin America. Long residence in Latin America. Speak both Spanish and Portuguese. Will consider major oil company aviation department. Excellent references. Available for immediate employment. W.M.C. requirements complied with. Address inquiries to Box 305, Institute of the Aeronautical Sciences.

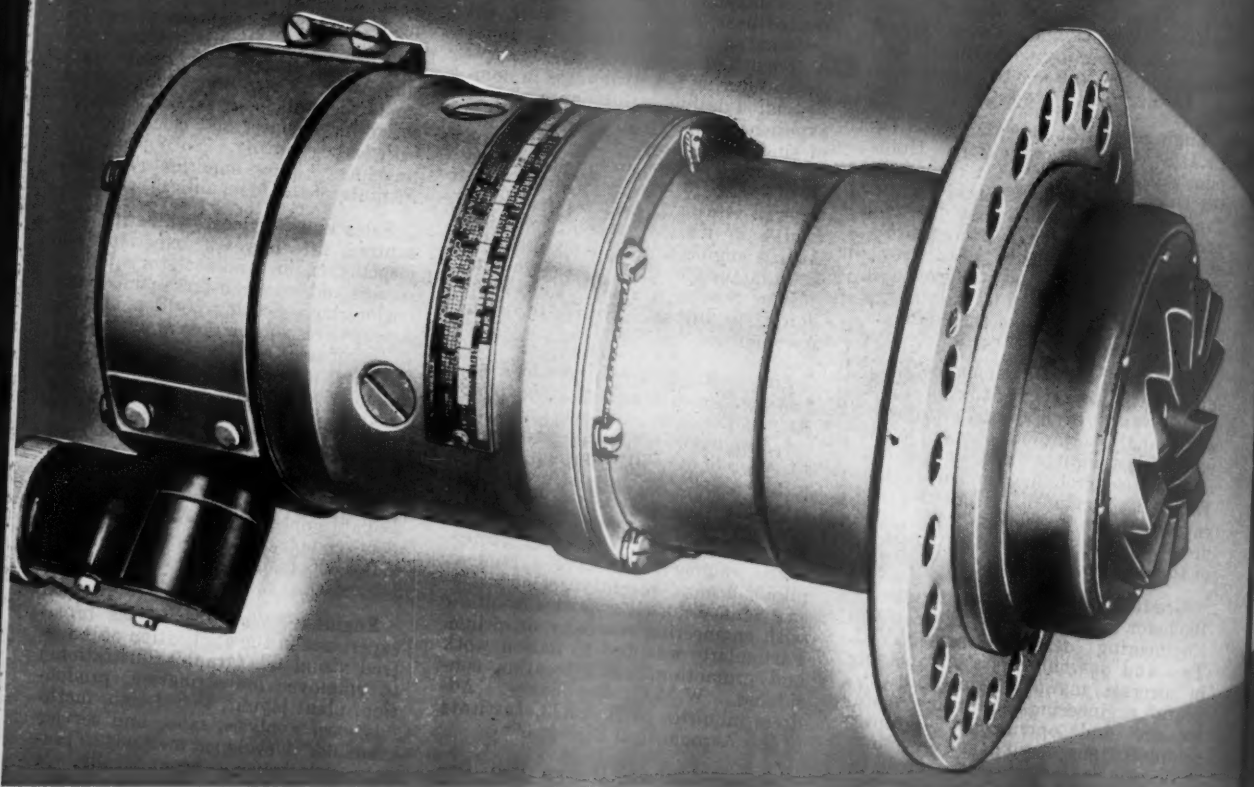
Engineer—Visualizer. Has broad experience in the application of industrial visual aids (graphic illustrations) to employee indoctrination, production, plant layout, tool design, methods, cost analysis, sales, and service manuals. Developed methods to prepare such drawings economically. Is prepared to act as consultant or accept contract for such work. Address inquiries to Box 302, Institute of the Aeronautical Sciences.

Aeronautical Engineer and Consultant—Seventeen years in the aviation industry on military and commercial airplanes including development, design, administration and direction of engineering groups, company representative at Service procurement centers and engineering flight test experience. Desires a permanent and responsible position in engineering or engineering sales or as a technical representative in the aviation industry or allied field. Address inquiries to Box 294, Institute of the Aeronautical Sciences.

Research—Economic Planning and reporting work desired. Good background in aviation manufacturing industry, B.S. Degree in Economics, now working toward Masters Degree in Economics. Connection desired with aviation manufacturer or transport line. Address inquiries to Box 286, Institute of the Aeronautical Sciences.

LIGHTWEIGHT

Eclipse aviation



DESIGN CHECK CHART FOR ECLIPSE TYPE 1416 AND 1423 LIGHTWEIGHT DIRECT CRANKING ELECTRIC STARTERS

APPLICATION:

✓ Eclipse Type 1416 and 1423 Direct Cranking Starters are designed to provide efficient direct cranking operation for engines of 200 to 3,000 hp.

✓ Type 1416 weighing 26 lbs. with a 6 in. mounting flange and 26¾ lbs. (average) with a 7 in. mounting flange is available for application to engines with 1:1 ratio of starter drive shaft to crankshaft.

✓ Type 1423 weighing 23.5 lbs. is available with 6 in. mounting flange for application to high output engines incorporating a 3:1 ratio of starter drive to crankshaft, and engines up to 450 hp., incorporating a 1:1 ratio of starter drive to crankshaft.

PERFORMANCE:

✓ The performance characteristics of the lightweight direct cranking starters are as follows:

	TYPE 1416	*TYPE 1423*
INPUT	24 volts DC	24 volts DC
CURRENT DRAW	165 amp. (at 400 lb. ft.)	185 amp. (150 lb. ft. at jaw)
CLUTCH SETTING	800 lb. ft.	375 lb. ft.
RATIO MOTOR TO JAW	133:1	43.5:1
JAW SPEED	49 r.p.m. (at 400 lb. ft.— 24 volts)	144 r.p.m. (at 150 lb. ft.— 24 volts)
ENGINE RATING	450 to 2,000 hp.	200 to 450 (1:1 ratio starter drive to crankshaft) and 2,000 to 3,000 hp. (3:1 ratio starter drive to crankshaft)

LET'S GO "ALL OUT" FOR VICTORY—
BUY MORE WAR BONDS

ECLIPSE
REG. U.S. PAT. OFF.

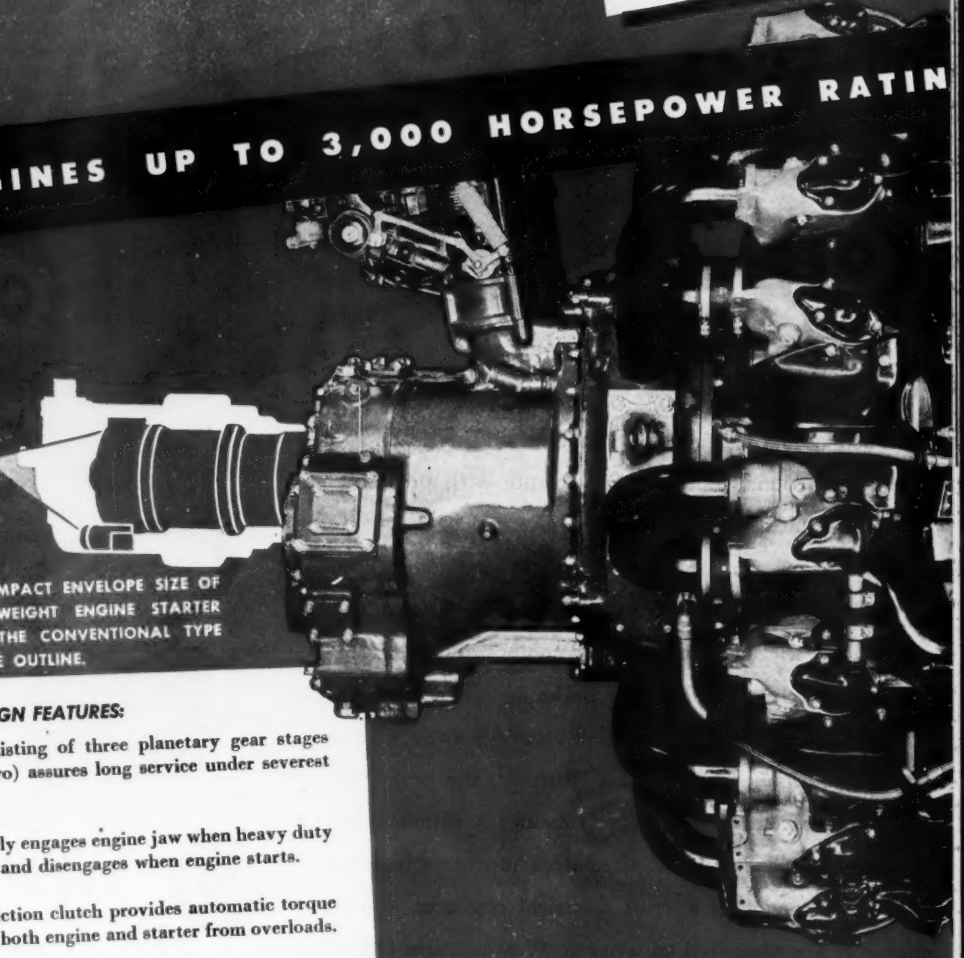
Eclipse AV

engine starter

ENGINEERING DATA

Starters
Previous Unit - 44 lbs
Type 1416 - 26 lbs
Weight Saving 18 lbs

FOR ENGINES UP TO 3,000 HORSEPOWER RATIN



✓ NOTE THE COMPACT ENVELOPE SIZE OF THE NEW LIGHTWEIGHT ENGINE STARTER COMPARED TO THE CONVENTIONAL TYPE SHOWN IN WHITE OUTLINE.

DESIGN FEATURES:

✓ Reduction gearing consisting of three planetary gear stages in series (Type 1423 has two) assures long service under severest operating conditions.

✓ Starter jaw automatically engages engine jaw when heavy duty electric motor is energized, and disengages when engine starts.

✓ A multiple disc, dry friction clutch provides automatic torque overload release protecting both engine and starter from overloads.

✓ Starter jaw oil seal prevents engine oil from entering the starter.

✓ Grease lubricated starter parts; gears, ball bearings, etc., require no attention between periods of engine overhaul.

✓ Design of starter housing permits speedy mounting or removal with conventional socket wrench.

AVIATION ACCESSORIES

Eclipse-Pioneer Division • Teterboro, N. J. • Los Angeles 36, Calif.

PRODUCT OF Bendix AVIATION CORPORATION

STOPS ...cond from 7500 rpm

When actuating turrets, trim tabs and a dozen other similar functions, motors must operate with precision in starting, rotating *and in braking*.

Brakes now available on Westinghouse motors assure virtually instantaneous stopping by two brake plates which clamp on a friction disc of special composition the instant the line switch is opened. This brake mechanism is simple and rugged, with a positive action . . . does away with the need for disconnecting clutches. Further, the brake is so designed that end-thrust on the bearings is eliminated.

For further information on motors incorporating these brakes and on other aircraft electrical products, aviation engineers are requested to write to Westinghouse Electric Corporation, Lima, Ohio. J-03230

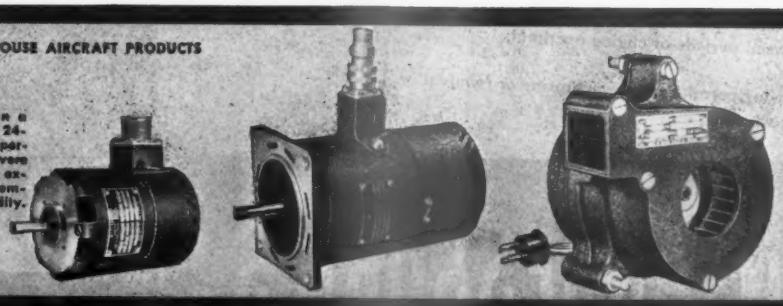
Braking from 7500 rpm to zero speed in 1/30 second, is now assured by this new, positive-action brake available on Westinghouse aircraft motors.

Westinghouse

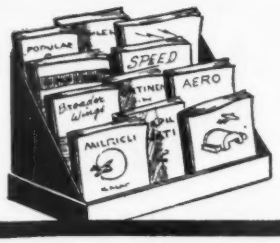
Aircraft Products

OTHER WESTINGHOUSE AIRCRAFT PRODUCTS

Aircraft Motors **in a complete range for 24-volt d-c systems. Operate under most severe flight conditions in extremes of altitude, temperature and humidity.**



Blower Motor cools electronic equipment or keeps temperatures constant. Available for 60 cycles, single phase, at 3000 rpm, and 400-800 cycles at 6700 rpm. Delivers 25 cfm.



Periodicals

Accessories and Equipment

Aircraft Oil Tanks of Magnesium Alloy. J. B. West. Particulars are given about oil tanks constructed of magnesium alloys, which, it is stated, are now standard equipment on many military aircraft. The requirements that these tanks are built to meet are outlined.

Consideration is given to the design and fabrication of oil tanks made from magnesium sheet alloys. Welding methods are described. The properties of Mazlo alloys are tabulated and the specifications of some of the aircraft-tank designs developed since the initiation of work on magnesium tanks are given in a second table. *Aluminum and Magnesium*, August, 1945, pages 16–19, 34, 3 illus.

Portable Airplane Engine Hoist. The aircraft engine hoist described in this article weighs only 470 lbs. but is capable of 2-ton capacity. Developed by the Lincoln Electric Company and the Forker Corporation, the unit incorporates as its principal feature a simple design consisting of two assemblies—the lower and upper booms. It is reported that these assemblies can be shipped in collapsed form and completely assembled by two men in the field within approximately 15 min. *Aero Digest*, August 15, 1945, pages 108, 146, 3 illus.

Developments in De-Icers. J. E. Gulick. The development of deicing equipment for aircraft is traced, with particular attention to the work carried out by The B. F. Goodrich Company. It is noted that wartime development in the deicing field falls into two general categories: (1) development of improved types of deicers; and (2) development of deicing equipment for parts of airplanes not previously protected in this manner. The writer describes the characteristics and advantages of the deicer known as Type 11, which has been on the market for certain types of aircraft for about a year. He also examines significant wartime advances that have been made in methods of deicer control and air distribution, and in the design and construction of deicers. Reference is made to the progress in adapting synthetic rubber to the requirements of airplane ice protection and to chemical treatments for natural rubber which bring about a reduction in ice adhesion. *Industrial Aviation*, August, 1945, pages 24, 26, 95, 2 illus.

Roots-Type Blowers for Aircraft Cabins. Cabin air-pressure requirements for civilian transport aircraft are discussed. Information is given about the design and performance of Marshall blowers, which are of the Roots type and have been supplied to the Royal Air Force in large quantities by Sir George Godfrey and Partners, Ltd. *Engineering*, August 10, 1945, page 106, 1 illus.

Aerodynamics

Airfoil Scale Effect Corrections as Applied to the Douglas A-20. George H. Tweney. It is stated that wind-tunnel test data, as obtained on an accurate scale model of a full-sized airplane, cannot be applied directly to obtain the characteristics of the airplane in flight but that the data must be corrected for scale effect. The writer applies procedures outlined in *N.A.C.A. T.R. No. 586* to an actual airplane, using some of the charts required for making scale-effect corrections. *Industrial Aviation*, August, 1945, pages 33, 34, 36, 37, 96, 7 illus.

Wing Pitching Moment Coefficient. W. L. Morse. The writer shows how Schrenk's method of finding the wing lift distribution can be extended in order to determine the pitching moment coefficient about the quarter-chord point of the mean chord at no lift. He explains the mathematical processes involved in calculating the fore-and-aft and lateral positions of the standard mean chord, and its quarter-chord point. *Aircraft Engineering*, July, 1945, pages 204, 205, 3 illus.

Air Cargo

New Device Facilitates Handling Air Cargo. A description is given of a monorail system that makes possible the loading of 4,500 lbs. of cargo into a Douglas DC-6 in less than 5 min. The device has been developed by engineers of United Air Lines, Inc. The idea of preloaded cargo containers is utilized in this system. *Aviation Maintenance*, August, 1945, pages 48, 49, 128, 130, 2 illus.

Air Power

Bombing Balance Sheet. Major Oliver Stewart. Based on a comparison of bombing methods and tonnage used by the Royal Air Force and U.S. Army Air Forces against Germany, this is an assessment of the power of incendiary, fragmentation, and blast bombing. It includes an evaluation of special bombs, such as those in the 12,000-

INDEX

Accessories and Equipment.... 61
Aerodynamics..... 61
Air Cargo..... 61
Air Power..... 61
Air Transport..... 63
Airplane Descriptions..... 67
Airports and Airfields..... 67
Avigation..... 68
Business and Finance..... 68
Civil Aviation..... 71
Control Equipment..... 71
Design..... 71
Electrical Equipment..... 73
Engines..... 75
Flight Technique..... 75
Fuels..... 75
Gliding and Soaring..... 75
Hydraulic Equipment..... 76
Inspection..... 76
Instrument Flying..... 79
Instruments..... 79
Landing Gear..... 79
Maintenance..... 79
Management..... 81
Marketing..... 81
Materials..... 81
Medicine..... 83
Meteorology..... 83
Naval Aviation..... 83
Paints and Coatings..... 83
Personalities..... 87
Photography..... 87
Plastics and Plywood..... 87
Production..... 87
Propellers..... 89
Radio..... 89
Reaction Propulsion..... 91
Reconversion..... 91
Reconversion of Equipment.... 91
Rotating Wing Aircraft..... 91
Stress Analysis..... 93
Superchargers..... 93
Testing..... 95
Training..... 95
Warfare..... 95
Weight Control..... 99
Welding..... 99
Wind Tunnels..... 101

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BG spark plugs have a way of proving themselves *in the air*—as they have done with Mid-Continent Airlines, and the many other airlines on which they are standard equipment. BG plugs feature reliability, economy and efficiency of operation. For this, they have been designed and built for over a quarter of a century—and will continue to be so built for the planes and engines to come.

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lb. and 22,000-lb. categories. In the study four variables are considered of prime importance: the size of the attacking force, the type of bomb used, the nature of the target, and the method of sighting and releasing the bombs. The conclusion is that when all these variables are correctly related to the target, heavy bombing can paralyze a country's war-making power. *Flying*, September, 1945, pages 21–23, 100, 103, 104, 105, 5 illus.

Air Transport

The Future of World Airlines: Britain. Lucien Zacharoff. Fifth in a series considering the civil air-transport potentialities of various countries, this article is concerned with Britain's prospects. It explains the fundamentals of Britain's three-way "chosen instrument" scheme of air transportation as well as the groundwork that has been laid for collaboration with Commonwealth air services. Divergence of British and American views (the one advocating regulated competition, the other unrestricted competition) at the International Civil Aviation Conference are noted. The article also stresses the importance of Britain as America's greatest competitor in international air transport. *Air Trails*, September, 1945, pages 32, 33, 97–101, 5 illus.

Airline Fleets Will Multiply Capacity. With an announcement of the number of planes United States air lines have on order, an estimate is made of the number of passenger-miles the air lines will be able to operate during 1946 and 1947 and the types of planes that will carry the air traffic. A table lists the number of planes and seats which each of the following companies had available in 1940, 1943, and 1945; the number they have on order; and the number they are expected to have during 1946–1947: American Airlines, Inc., American Export Airlines, Inc., Braniff Airways, Inc., Chicago & Southern Air Lines, Inc., Colonial Airlines, Inc., Continental Air Lines, Delta Air Corporation, Eastern Air Lines, Inc., Inland Air Lines, Inc., Mid-Continent Airlines, Inc., National Airlines, Inc., Northeast Airlines, Inc., Northwest Airlines, Inc., Pan American Airways, Inc., Pan American-Grace Airways, Inc., Pennsylvania-Central Airlines Corporation, Transcontinental & Western Air, Inc., United Air Lines, Inc., Western Air Lines, Inc. *Western Flying*, August, 1945, page 56.

New Quick Release Cargo Tie-Down. Data pertinent to the construction and operation of a device for securing air cargo are reported. Designed by Davis Developments, the unit is described as consisting of a 15-ft. length of 2-in. cotton webbing with a dural hook at each end having an adjustable quick-release and take-up buckle between them. The hooks can be fastened to floor-eyes or other securing points, or to additional lengths of webbing where longer lengths are required. *Aero Digest*, August 15, 1945, page 112, 1 illus.

"Elastic Traffic" Plan Advocated for Building Feederline Business. John W. Moore. In order to meet demonstrated needs of seasonal air-traffic fluctuations, the Air Transport Traffic Manager of the Port of New York Authority recommends the merits of an area-certificates plan for feeder air lines. As recently suggested to the C.A.B. by the Port of New York Authority, such certificates would grant a carrier the right to provide nontrunkline service within a prescribed region. The carrier would have considerable freedom of choice as to the towns to be served on particular schedules and could adapt the service to fluctuating requirements, varying with seasonal and other factors. *Aviation*, August, 1945, pages 171, 251–253, 2 illus.

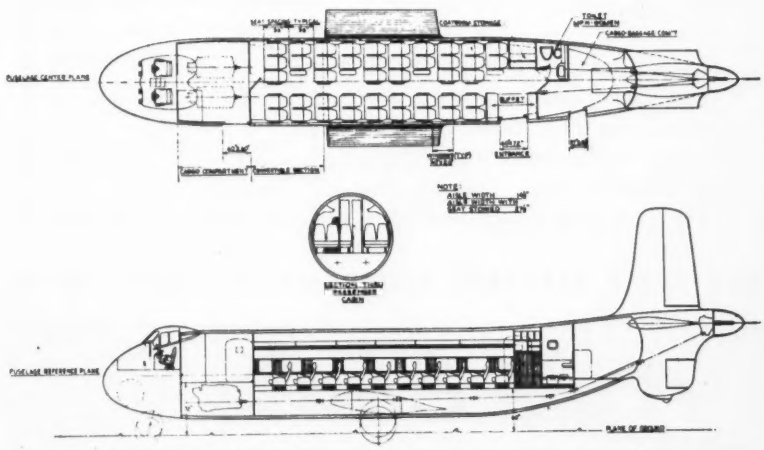
A Comparison of Operating Costs. Major J. D. Rennie. Costs of operating the Blackburn B-49A are compared with operating costs for the Douglas DC-4, Douglas DC-7, and a proposed Pan American transport plane designated the "Type 10." The comparison takes into consideration the effect on operating costs of the airplane's size; whether it is a flying boat or a landplane; whether it is powered by turbine power units or reciprocating engines. Total direct flying costs are studied under the groupings of fuel and oil; depreciation of air frame and engines; maintenance of air frame and engines, and servicing costs; crew pay and expenses; insurance, public liability, and accident; and loss on investment. Comparative results for all aircraft are given in tabular and in chart form.

From this study it is concluded that there is a reduction in operating costs per ton-mile for the larger aircraft, a slight reduction in favor of a flying boat as compared with a corresponding landplane, and a considerable reduction in favor of propeller-turbine engine units as compared with reciprocating-engine units. It is also stated that the flying boat offers advantages in operating costs over the landplane for trips of from 2,000 to 3,500 miles. *The Aeroplane*, July 20, 1945, pages 70, 71, 2 illus.

Decision in Air Policy. Franklin D. Walker. A discussion of the C.A.B.'s decision authorizing Transcontinental & Western Air, Inc., American Export Airlines, Inc., and Pan American Airways, Inc., to operate intercontinental air routes across the North Atlantic. It is stated that this decision strikes the keynote of regulated competition on an area basis for future international air operations by United States air lines. The northern, central, and southern routes along which the three air lines will conduct their transatlantic activities are illustrated. *Flying*, September, 1945, pages 24, 25, 132–134, 136, 1 illus.

Plane Sense and Bush Flying. Part II. Dale S. Atkinson. Continuation of a series of articles analyzing the potentialities, costs, rates, and revenues of an air-transport operation in the northwestern part of Canada. Part II discusses the main factors to be considered in the establishment of a bush-line operation: rates, traffic density, types of traffic, and nature of competition. Other factors examined are space/weight values in selecting aircraft for such operation, fixed and variable charges that may be anticipated by the operator, and the possibility of air-mail subsidies. *Canadian Aviation*, August, 1945, pages 60, 62, 2 illus.

The Future of Postwar Commercial Aviation in Canada. W. B. Burch-



Drawings of the new Douglas DC-8, powered by two liquid-cooled Allison V-1710 engines producing 3,260 take-off hp. The engines are housed in the fuselage directly behind the pilots' compartment and are connected by two 60-ft. sectional shafts to the dual counter-rotating reversible propellers at the tail of the plane.

all. An exploration of the potentialities of commercial air transport in Canada. This discussion by the Executive Secretary of The Air Industries and Transport Association is confined mainly to domestic services and includes in its scope consideration of the possibilities of main-line services, feeder lines, air-mail carriage, and use of the airplane for such work as fire protection and aerial survey. Types of planes adapted for service in Canada are noted. A tabulation of the prewar growth of air transport in Canada from 1923–1943—expressed in terms of number of aircraft, personnel, passengers, freight and express pounds, and mail pounds—forms a basis for estimates of future requirements and opportunities. *Commercial Aviation*, July, 1945, pages 30–32.

Cruising Performance of the Short Shetland. Capt. S. T. B. Cripps. An analysis of the cruising performance of the Short Shetland is made in conjunction with a fuel-reserve calculation for operating across the North Atlantic. The calculations given are for operations on the North Atlantic route-westbound, Mid-Atlantic route-westbound, North Atlantic route-eastbound, routes to the Middle East, and the Poole-Cairo-Karachi route. *The Aeroplane*, July 27, 1945, pages 106–108, 6 illus.

Europe's Air Transport. Victor L. Gruberg. A study of proposed routes for the re-establishment of European civil air services. The routes mentioned are based on proposals submitted by the following 18 nations to the International Conference at Chicago: Cuba, Czechoslovakia, Denmark, Egypt, Iceland, Iran, Lebanon, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, Syria, Turkey, United States, and Yugoslavia. Cited as indicating the trend of future air transport development in Europe, the suggested pattern of air routes is illustrated by a 2-page map. *Flight*, July 26, 1945, pages 92A–92D, 2 illus.

No-Show Is a Poor Show. W. G. Rathbone. Attention is called to the costliness and inconvenience resulting from last-minute cancellations of airline reservations or failure to occupy the reserved seat. Principal causes for "no-shows" and late cancellations are summarized. Methods instituted by Trans-Canada Air Lines to combat the two evils are described. *Commercial Aviation*, July, 1945, pages 46, 48.

Conference in Print. The major part of the August, 1945, issue of *Air Transport* contains papers prepared for an Air Transport Association Engineering and Maintenance Conference. This compilation was prepared by *Air Transport* as a "conference in print" to take the place of a meeting banned by wartime travel restrictions. The technical subjects were suggested by the air lines. The articles are:

"Air Transport Will Build a New World Commerce," by E. S. Gregg. The writer shows how American design and maintenance methods have earned world-wide recognition. Other subjects discussed are competition, rates, and the outlook for the industry. Pages 22–24, 4 illus.

"A Pilot Speaks," by Capt. Frank Kern. The opinions and complaints voiced by the men who fly transport airplanes are offered in the spirit of constructive criticism. Among the points emphasized are better range of vision, accessibility of controls, and greater comfort. Pages 25, 26, 1 illus.

"A Mechanic Speaks," by Elbert Cheyno. An experienced air-line mechanic examines the causes of the high man-hour rate and high maintenance costs. Accessibility provided through better aircraft design, modern ground equipment, and the selection of mechanics on the basis of aptitude tests are urged as important needs. Pages 26, 27, 2 illus.

"Keeping the Passenger Comfortable," by Karl O. Larson. Suggestions are given for providing comfortable accommodations for air-transport passengers through suitable heating and ventilating equipment. The advantages and disadvantages of the so-called "package units" are examined, and the problems connected with heating and ventilating in aircraft are outlined. Pages 28–34, 10 illus.

"Maintenance Methods and Facilities," by Thomas D. Brooks. Improved methods and equipment for aircraft maintenance are reviewed, with specific examples given to show how difficult

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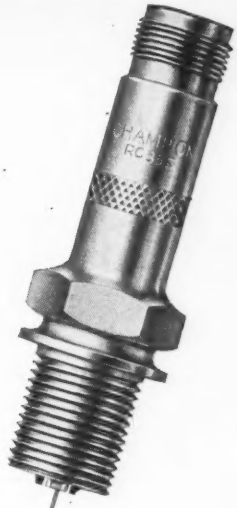

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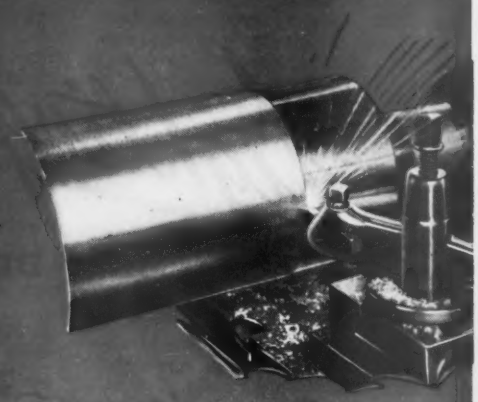

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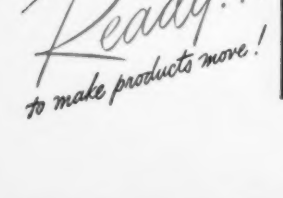

Rotary files, operating between 4500 and 7000 r.p.m., are widely used to clean up irregular surfaces on magnesium castings.

Machining mass production parts such as this blower section for a radial aircraft engine is materially speeded with magnesium.

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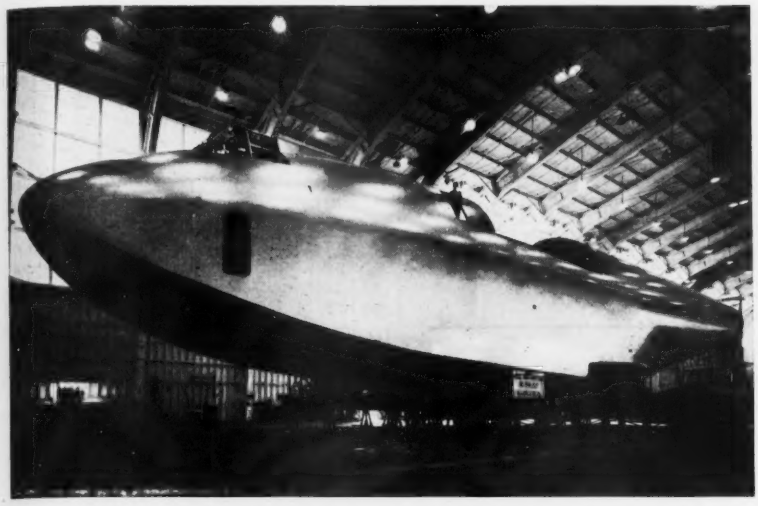

The 220-ft. hull of the Hughes H-4 cargo airplane. The wing, shown on page 143, will be placed in the cutaway section in the center.

problems have been overcome. The article, which was written by the Superintendent of Maintenance of Chicago and Southern Air Lines, is supplemented by comments by maintenance engineers of various other air lines. Pages 35–41, 9 illus.

"Save Airplane Weight with D.C.," by W. L. Berry and J. P. Dallas. Facts and figures are given to support the point of view favoring direct-current equipment for aircraft. Reduced weight and other advantages are emphasized. Pages 55, 56, 59, 60, 65, 67, 68, 7 illus.

"What's Needed for Refueling? A Symposium." Opinions are expressed by the maintenance-engineering executives of leading air lines with regard to present methods and future improvements in equipment for fueling transport aircraft. Recommendations are made with regard to the mechanical facilities for handling aircraft fuel, measuring rates of flow, safety precautions, and other factors. Pages 71, 72, 75, 76, 79, 8 illus.

"Overhaul Times." Time schedules governing the operations involved in aircraft overhaul are studied. The detailed overhaul operations of leading air lines are tabulated, with figures showing approved overhaul periods for the different companies. Pages 80, 83, 84, 87, 1 illus.

"Corrosion—Aviation's Bogeyman," by Gilbert K. Brower. The writer describes the three distinct basic types of corrosion, as they affect aircraft operation. These are chemical reaction, intergranular corrosion, and electrochemical corrosion. Examples of each are given and methods of prevention are suggested. *Air Transport*, August, 1945, pages 115, 116, 119, 120, 123, 124, 6 illus.

Airplane Descriptions

Bristol Aeroplane Company Developments. Part II. This is the second part of an article describing some developments that are being carried out by the Bristol Aeroplane Company, Ltd. In a visit to the helicopter department of the Fulton works a model and full-scale mock-up of a prototype helicopter were inspected. Gas turbine developments are described. Information is given about the Bristol air-sea rescue vessel that is powered with a radial aircraft engine.

Technical improvements incorporated in the Hercules 100 power plant are noted. It is stated that the most important of these is a new supercharger, with the mixture entry passages and the impeller element of improved shape and design. The maximum power rating has been increased by over 10 per cent in brake horsepower, while the altitude at the same boost pressure has been increased by about 60 per cent compared with the previous series of engines. *The Engineer*, July 13, 1945, pages 25, 26, 2 illus.; " 'Bristol' Aircraft and Aero Engines," *Engineering*, July 20, 1945, pages 46–48, 2 illus.; "Bristol Aircraft Output," *Modern Transport*, July 7, 1945, pages 3, 7, 18, 6 illus.

Aircraft of the U.S. Armed Forces. A comprehensive list of aircraft in use by the U.S. armed forces tabulates the popular name of each plane, its Army or Navy designation, the company that designed it, and some remarks pertinent to its distinguishing features, production, applications, etc. The list is divided into classifications of bombers, attack bombers, fighters, transport and utility cargo planes, trainers, liaison and observation aircraft, photographic planes, and gliders and helicopters. A few still secret aircraft are omitted from the schedule. *Flying*, September, 1945, pages 70, 71.

The Last Enemy. Accompanied by brief descriptive data, photographs are shown of 13 Japanese operational aircraft. These include fighters, bombers, reconnaissance aircraft, and combat flying boats. *The Aeroplane*, August 3, 1945, pages 128, 129, 13 illus.

PT-19. Leighton Collins. An appraisal is made of the handling and operational characteristics of the Fairchild PT-19 from the point of view of a civilian pilot. Details are reported on a step-by-step basis as the plane is followed through routines and maneuvers of cockpit check, take-off, climb, level flight, stalls, aerobatics, landing, etc. *Air Facts*, September, 1945, pages 30–34, 36–38, 40–43, 46–50, 52–55, 2 illus.

Airports and Airfields

Night Lighting for Small Airports. A low-cost system is suggested for lighting small airports at night and increasing the utility of the personal airplane. The basic equipment consists of a portable "Glide Path Indicator" unit, described and illustrated in the article. This equipment operates on the same principle as the British instrument glide path, translated into lights instead of visual radio signals. *Airports*, August, 1945, page 20, 1 illus.

Establishment and Maintenance of Cover on Unpaved Surfaces of Airports. Lt. Col. R. H. Morrish. Methods of cultivating a sod surface for the unpaved areas of airfields are discussed. It is stated that good drainage, proper fertilizer, and timely planting of well-selected grasses will provide an economical, satisfactory surface that will keep the airport free from dust and mud, and prevent erosion and gullying. Information is given about the selection of suitable grasses, methods and seasons for planting in different sections of the country, and the kinds of grasses that are best for various climatic conditions. For areas where sod growth is not feasible, other types of vegetation, as well as other means of surface protection, are suggested. Detailed instructions are given for the selection and application of fertilizers, mowing and cultivation of grasses, provision of drainage, and other factors. Tables summarize the recommendations for grasses and legumes for different regions and the drainage characteristics of various surface materials. *Engineering News-Record*, August 23, 1945, pages 96–100, 7 illus.

Permit Exclusive Airport Leases. John S. Wynne. Stating that Section 303, which has been interpreted as prohibiting exclusive franchises for nonscheduled, fixed-base common carrier operators, conflicts with the purposes of the Civil Aeronautics Act, the writer urges its repeal. He gives reasons why, under certain circumstances, exclusive franchises are in the interest of good airport practices. As a substitute for Section 303 it is suggested that the C.A.B. adopt a policy that no general exemption be issued for nonscheduled, fixed-base common carrier operators,

but that each fixed-base operator apply to the Board individually for exemption. *Airports*, August, 1945, page 24.

Airport Planning for Private Flying. Part III. This is the third article of a series containing advice about the practical steps to be taken in the construction and development of Class I and Class II airports. Details of turfing, soil stabilization, paving, marking, and lighting are dealt with in the current article. *Southern Flight*, August, 1945, pages 44, 45, 1 illus.

"Don't Fence Me In!" Gil Brace. A protest against restricting private pilots from landing anywhere but at designated airports. The need for airplanes in regions where fields and pastures are the only available landing sites is illustrated by the experiences of one cattle rancher and manufacturer of oilfield equipment. The advantages and economy of the personal plane to this man in both his businesses is indicated and the fact is stressed that these businesses and others like it would suffer if landing of the airplane were limited to conventional airports. *Skyways*, September, 1945, pages 26, 27, 64, 66, 3 illus.

An Airport Manager's Report. A report of a large airport's operations is made by the airport manager to his city. It not only includes an analysis of actual income and expenses, but also gives recommendations as to revisions of rentals and fees. A table of landing fees shows the comparative charges made at various representative fields throughout the country. *Airports*, August, 1945, pages 29, 30.

Nature Deals a Trump to Marine Airport Designers. Capt. C. H. Schildhauer. Indicating advantages of the flying boat as compared with the landplane, the writer stresses the natural economies afforded by seadromes. He discusses building, docking, terminal facilities, and patrol requirements for seadromes from an engineering point of view. Three schemes for different seadrome layouts are presented, together with specifications for cable-connected lane markers. *Aviation*, August, 1945, pages 106–110, 10 illus.

Safety on the Airport. John H. Frederick. The necessity is stressed for having signs around an airport which will help minimize the danger of accidents to passengers and patrons. In indicating the types of accidents that can be prevented with the aid of warning signs, the article features signs warning against moving propellers. *Southern Flight*, August, 1945, page 46.

Private Aircraft at Terminal Airports. Wilfred M. Post, Jr. The system of traffic control in use at the Allentown-Bethlehem Airport is outlined. It is shown how this system functions to coordinate both scheduled and nonscheduled air operations. *Airports*, August, 1945, pages 59, 68, 2 illus.

Building the Small Airport. Part VI. B. H. Biggers and J. P. Cockey. The problem of runway paving is considered in one of a series of articles about small-airport construction. It is noted that the kind and capacity of paving will depend largely on the amount of funds available, and that for inexpensive fields paving may not be necessary. It is stated that where grass will grow and only light traffic is expected, turf will usually provide a good surface. The planning of turf runways is detailed. *Aviation Maintenance*, August, 1945, pages 72, 73, 2 illus.

The views and opinions expressed in this section are exclusively those of the writers or publications named. They are in no case to be construed as those of the Aeronautical Engineering Review or the Institute of the Aeronautical Sciences.

Heating, Ventilating, and Air Conditioning Problems in Airport Design. In a compilation of short articles by members of the staff of Albert Kahn Associated Architects and Engineers, Inc., comments are made about the heating, ventilating, and air conditioning of airport buildings of the future. Consideration is given to the requirements for hangars, administration buildings, and other structures. The first article includes "General Design Problems," by Roland A. Wank; "Heating Facilities," by G. S. Whittaker; "Ventilation and Air Conditioning," by H. E. Ziel; "Fuel Piping," by H. D. Unwin. *Heating and Ventilating*, August, 1945, pages 68–74, 5 illus.

Your Own Airport! Kurt Rand. Specific suggestions are offered for starting a small airport on as little capital as $2,000. A list of C.A.A. publications containing pertinent information supplements the advice in the article. *Flying*, September, 1945, pages 33, 34, 112, 114, 116, 118, 5 illus.

Avigation

Evolution of the Primary Equations of DF Mathematics. Tappan Collins. In a study of the mathematics underlying the practical application of radio direction finding (DF) to avigation, the present limitations of the DF method are analyzed. The disadvantages of the system are outlined with respect to its present use in conjunction with conventional methods of navigation. It is stated that the deficiencies of the north-seeking compass constitute a grave restriction on the DF method, and that such deficiencies should be isolated from the problem by indexing DF readings directly to each other instead of to the compass indications. Only in this way can the radio method be made to approach its utmost possibilities. The writer recommends that the first step is to rectify the applicable mathematics of celestial navigation which, he states, now lags far behind the technical development of the equipment. The derivation of the general equation for the tangent to the true locus of DF avigation is explained, and suggestions are made for the points at which care should be taken so that an accurate solution may be obtained. *Aero Digest*, August 1, 1945, pages 38, 39, 148, 151, 2 illus.

Finding the Navigational Stars. Part 8. Ben C. Kenny. After brief remarks concerning the apparent motion of the celestial sphere and the relationship of Sidereal Hour Angle to Greenwich Hour Angle, the eighth section of a continued article explains the identification of two additional navigating stars. These are Deneb, in the constellation Cygnus, and Altair, in the constellation Aquila. They are described as part of an extremely distinctive large pattern in which they, with Vega, form the corners of a right triangle. How these points and figures are identified when clouds obscure parts of the sky is explained, so that the navigator may become familiar with the positions and surroundings of the important stars even when partial cloudiness prevails. Night photographs of the two sections of the sky are accompanied by diagrams. *Aero Digest*, August 15, 1945, pages 72, 73, 5 illus.

Business and Finance

Is CAB Regulation of Airline Securities Necessary? John H. Frederick. The writer, a professor of transportation at the University of Texas, explains why he believes that control over air-carrier securities by the Civil Aeronautics Board is not only unnecessary but also undesirable. In explaining his stand, he contrasts the present financial position of the air lines with that of the railroads when control of railroad securities was assumed by the Interstate Commerce Commission. Objections to C.A.B. control of air-carrier stocks are based on three main contentions: (1) C.A.B. control would place the air lines in such a position that they would probably be unable to take advantage of favorable situations in the money market. (2) C.A.B. control might tend to be misinterpreted and would thereby injure investors instead of benefit them. (3) C.A.B. control would tend to restrict air-line enterprise and foster further paternalism in government. *Aviation*, August, 1945, pages 170, 262–265.

An Operator's Accounting System. A description of an accounting system especially adapted to the requirements of the aircraft service operator. The important factors in the system, the four sections comprising the financial statement, are explained. These are the balance sheet; the profit-and-loss statement; analysis of expenses; and analysis of sales, cost of sales, and gross profits. A chart of accounts and a financial-statement form are shown. *Airports*, August, 1945, pages 46, 47, 2 illus.

Wall Street Eyes the Lightplane Makers. Raymond L. Hoadley. Analyzing two divergent lines of reasoning, the writer reports on the current

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- Electrical and mechanical interlocks—automatically insuring proper manual operation
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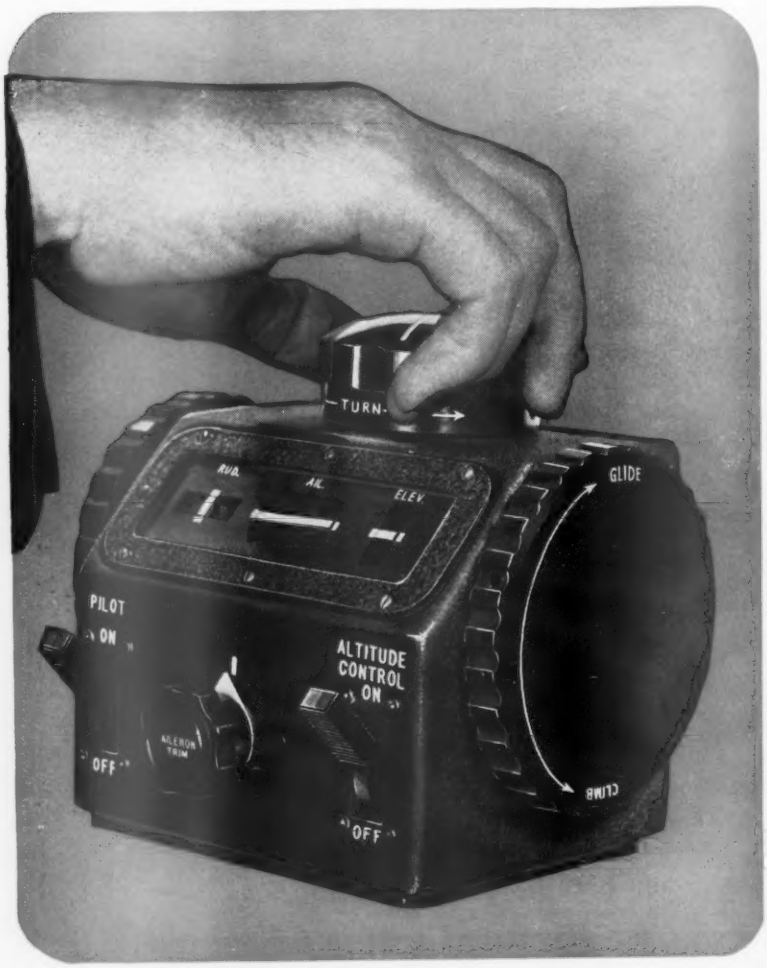

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attitude of Wall Street investors toward the equities of personal-aircraft companies.

He summarizes the reasons why some investors are in favor of speculative commitments in personal-plane stocks, and why others are firmly against them. Financial factors that contribute to each school of thought are noted. *Aviation*, August, 1945, pages 179, 253–255.

Civil Aviation

Air Racing and Its Future. Alexander Henshaw. The writer indicates the value of air racing to the development of better aircraft. He explains some of the reasons why the sport has not become more popular; one of the main factors mentioned is the lack of incentive, in the form of adequate prize money, for constructing specialized racing airplanes. In order to bring air racing into greater favor with competitors and public, he suggests that two races be organized: one for sheer speed, over a well-chosen and safe course; the other based on a formula to encourage the right progress in aircraft design, so that range, speed, horsepower, pay load, and operators' requirements all play their part. *The Aeroplane*, August 3, 1945, pages 134, 135, 4 illus.

Government Aviation Policy and the Air Transport Board. W. B. Burchall. The policies of the Canadian Government and Air Transport Board with regard to future civil aviation are reviewed, with answers made to the following questions: (1) Has the Canadian Government an aviation policy? (2) What is the Government's policy regarding airports? (3) Why the delay in the issuance of new licenses by the Air Transport Board? (4) How does the Air Transport Board propose to classify the various services? (5) What about "grandfather rights" and protection for the smaller operators? (6) How is it proposed to implement the statement made in the House by the Hon. C. D. Howe that assistance may be given to newly established air lines, whether capital or by way of operating subsidies? (7) What about payment of a decent rate for the carriage of mail into the remote areas? (8) Why should the small charter operator have to do so much clerical work? (9) Will applicants for licenses have an opportunity to get a full and impartial hearing before the Air Transport Board? *Canadian Aviation*, August, 1945, pages 76, 78, 106, 120, 1 illus.

Dust Crops and Reap Profits. Noting various applications for employment of the airplane in crop dusting, the writer outlines some of the problems involved in this type of airplane work. He offers advice to the duster on how to build up his business, while warning him of certain pitfalls that must be avoided. In addition, the article contains information about the building and mounting of the hopper, conveyer, and power units designed by the U.S. Department of Agriculture for conversion of light planes into crop-dusting aircraft. Schematic drawings and a list of materials supplement the directions for constructing these units. *Aviation*, August, 1945, pages 166, 167, 246, 248, 249, 251, 3 illus.

Let the Flyer Be Wary. Russ Brinkley. Pilots are warned against errors of judgment responsible for mid-air collisions. Based upon C.A.A. investigations, 13 different reasons are given for 31 mid-air collisions that occurred during recent months. *Aero Digest*, August 15, 1945, pages 47, 141.

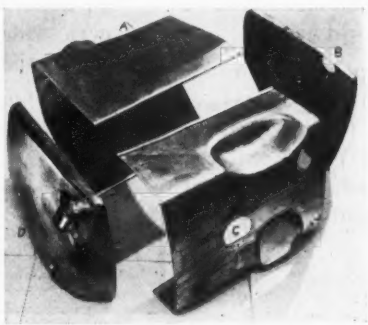
Control Equipment

Coordinated Controls Relieve Flight Fatigue. The layout and equipment of the C-97's control cabin are surveyed. Among the features noted are the seating arrangement for the five crew members, which is said to facilitate better teamwork; the location of instruments for each member; and the employment of a single control stand enabling one man to operate the airplane if necessary. *Aviation*, August, 1945, pages 172, 173, 5 illus.

Design

Design Analysis of the Vought "Corsair." William C. Hoff. The structural design of the Vought Corsair ship-based aircraft is analyzed. Particular attention is given to the construction of the gull wing, which is a characteristic of the Corsair. It is noted that except for the gull wing, the general layout of the Corsair is conventional for single-engined airplanes. Information is given about the construction of the fuselage, ailerons, flaps, tail surfaces, landing gear, power plant, etc. The armament installation also is described. Photographs and drawings of the component parts are shown, as well as a colored "X-ray" view of the complete aircraft. *Industrial Aviation*, August, 1945, pages 7, 8, 10, 12–14, 16, 18–23, 96, 97, 18 illus.

Design Analysis of the Fairchild C-82 Packet. Part I. Irving Stone. This article begins a comprehensive engineering study of the Fairchild C-82 long-range transport aircraft. Illustrated by numerous schematic drawings and photographs, Part I is concerned with the major air-frame components. It investigates design and construction details of the fuselage main-body section, sides, upper front section, and upper rear section; nose-gear bulkheads and beams; cargo doors; cockpit enclosure. Particulars are also given on the wing center section; nacelle-frame assembly; outer wing panel; flaps and ailerons; and booms and empennage.



Photograph Courtesy Aluminum Company of America

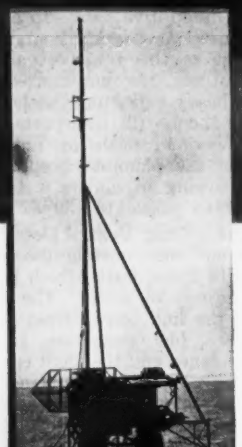
The four parts comprising a 40-gal. aircraft-engine oil tank before joining. The bottom skin, A, is formed on a stretcher press using a hollow, cast aluminum male die heated with strip heaters. The right and left heads, B and D, respectively, and the top skin, C, are drawn in double-action toggle presses of 275-ton capacity.

A table contains a summary of the Packet's fundamental design information and descriptive data. In a report of the general considerations underlying the design of this transport airplane, three features are emphasized: (1) carrying heavy bulky units without dismantling them; (2) transportation of paratroopers and means for rapid conversion of the plane to hospital use; and (3) towing of gliders. *Aviation*, August, 1945, pages 115–139, 32 illus.

Hughes Flying Boat. Details are given about the construction of the Hughes H4 flying boat, which is built almost entirely of wood. The article discusses the hull construction, engine installations, fuel, pneumatic and hydraulic systems, and the flight controls. A short table of design data is included. *Automotive and Aviation Industries*, August 15, 1945, pages 18–21, 92, 8 illus.

Toward Better Lightplane Performance. Henri L. Portine. The writer specifies certain design criteria which he states are required for the light plane of the future. Defining the light plane as an aircraft so called because of its low wing loading, he also explains the fundamental principles of wing loading and describes five factors upon which the efficiency of a selected wing form depends. However, it is pointed out that, in addition to low wing loading, future purchasers of light planes will also require extended ranges and greater pay load. *Skyways*, September, 1945, pages 48–50, 86, 88, 2 illus.

Designing Tomorrow's Personal Plane. Part III. Ralph H. Upson. The third part of an article dealing with the various design problems involved in developing a light plane for the postwar market presents a comparison of specific features of a light plane. Analyzing the advantages and limitations of each alternative, the writer discusses the factors to be considered in making a choice relative to high wing vs. low wing; strut-braced vs. cantilever wing; fixed vs. retractable landing gear; and conventional vs. tricycle gear. With reasons offered for his conclusions, he advises in favor of the low cantilever wing



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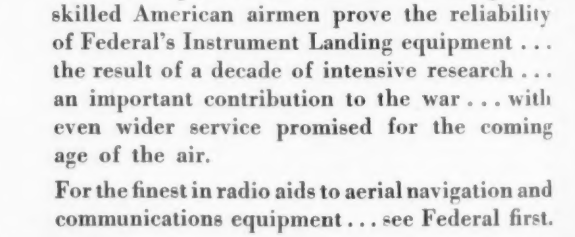

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and the retractable, tricycle landing gear. *Aviation*, August, 1945, pages 140–143, 1 illus.

Design Details of the Goodyear Model K. Airship. Part II. Capt. C. V. S. Knox. Second half of a comprehensive engineering study of the Goodyear Model K airship used by the U.S. Navy for patrol and convoy escort work. Part II is concerned mainly with details about the components, construction, and design of the airship car. It also contains information relative to the instruments, controls, crew accommodations, armament, radio equipment, and accessories. Fuel tanks, engines, and landing gear are among other particularized items. Among the numerous drawings and photographs illustrating the design analysis is one giving a cutaway view of the entire car of the Model K airship, which shows the location and design of the parts and accessories. *Aero Digest*, August 1, 1945, pages 64–70, 151, 152, 10 illus.

204-Passenger Plane to Have Radiant Wall Heating. Howard Schmidt. Information is given about the radiant wall heating system that is to be incorporated in the Model 37 Consolidated Vultee 204-passenger transoceanic air liner ordered by Pan American World Airways. It is explained that this plane will fly at a ceiling of about 30,000 ft. and at a cruising speed in excess of 300 m.p.h.

It is stated that where temperatures of from −20°F. to −65°F. and high external heat transfer rates caused by velocity are encountered, the weight of insulation necessary to maintain passenger comfort becomes excessively high in planes where radiant heating is not used. Utilization of the familiar hot-air system under normal flight conditions of the Model 37 would require convective air at temperatures far above the respiratory comfort range to maintain bodily warmth. Such temperatures induce drowsiness and extreme discomfort. In radiant heating, hot air is passed through wall spaces in place of insulation, and in addition, heating inner walls slightly above body temperature does away with the radiational unbalance that formerly tended to draw heat from the passenger through the cold wall. Thus, in effect, a heavy static insulation is replaced with an almost weightless dynamic insulation of warmed air. The heating function is separated from the respiratory or ventilating function and ventilating air can be supplied at comfortable velocities and properly humidified temperatures. *Heating and Ventilating*, August, 1945, pages 84, 85, 2 illus.

Making the Cockpit Practical for the Pilot. G. F. Beal. A discussion of some ideas for the practical improvement of the cockpit, which were compiled from a questionnaire answered by representatives of the scheduled air lines of the United States. The pilots' suggestions are examined in sections devoted to cockpit-window layout, instrument-window arrangement, cockpit lighting, pilot comfort, and the type, location, and accessibility of controls. *SAE Journal*, August, 1945, pages 437–440, 496 (Transactions).

The irregularity of receipt of publications from abroad necessitates the review of articles in issues several months late. This is done to provide readers with information regarding foreign technical progress as soon as the issues are available in the United States.

Design Details of the Boeing B-29. Part I. The first installment of an engineering analysis of the Boeing B-29 Superfortress gives a general description and the specifications of the aircraft, as well as details about the various components and parts of the pressurized fuselage. In somewhat briefer form, data are listed about the engine nacelles, engines, propellers, landing gear, and flaps. *Aero Digest*, August 15, 1945, pages 61–66, 9 illus.

The Merchant Flying Ship. J. D. Rennie. Concerned mainly with aircraft types of over 100 tons gross weight, this article considers the merits and demerits of the flying boat, based on three prime deductions: (1) The operational efficiency, expressed in ton-miles per gallon of fuel, is higher for the flying boat than for the corresponding landplane. (2) Landing-gear problems may conceivably set a lower limit to the size of the landplane. (3) The prototype design and development period is less for the flying boat. Landing facilities, costs, and insurance are other factors considered. *Flight*, July 5, 1945, pages 7–9, 5 illus.

The Flight Strength Envelope. R. G. Worcester. A simplified explanation is offered, for the benefit of pilots who lack engineering training, of some of the problems involved in the design of an airplane. The flight-strength envelope (or the V-n diagram) is defined as a method of showing diagrammatically the strength of the airplane structure, and a typical diagram of that type is reproduced and explained. The effect of design modifications on the center of gravity is discussed, and the pilot is advised to become familiar with the placing of equipment and the disposition of the loading space so that the greatest safety and comfort in flight may be attained. Brief reference is made to compressibility and the measurement of forces acting on the airplane at speeds in the vicinity of the speed of sound, and to instruments for indicating the Mach Number. *The Aeroplane*, July 13, 1945, page 41, 1 illus.

Descriptive Geometry in Engineering. G. Orloff. The writer shows how many engineering problems in descriptive geometry may be treated successfully by graphical methods. Methods are described for the determination of true sizes and clearances. A problem involving the intersection of a plane and a solid is solved. Information is given about the application of descriptive geometry to the development of figures. The application of descriptive geometry to vector analysis and to three-dimensional motion analysis is emphasized. Examples are worked out mathematically. *Aircraft Engineering*, July, 1945, pages 197–203, 11 illus.

Electrical Equipment

A 208Y/120-Volt 120-Ampere Three-Pole 400-Cycle Electrically Operated Aircraft Circuit Breaker. C. H. Titus and P. J. Reifshneider. The paper describes a 120-amp. remotely controlled electrically operated air circuit breaker designed for use as a bus sectionalizing, ring tie, or generator breaker on the 400-cycle grounded-neutral system of large aircraft. The interrupting rating of this breaker is 3,800 amp. at all pressures from sea level to 50,000-ft. altitude. It is explained that the closing solenoid and shunt trip coils have been designed to operate over a wide range of ambient temperature and control voltage. Weight and size have been held to a minimum. *Electrical Engineering*, August, 1945, pages 551–555 (Transactions), 15 illus.

Failures of Electrical Equipment from Poor Mechanical Design. Col. T. B. Holliday. The causes of aircraft electrical equipment failures are examined. Emphasis is placed on the importance of designing for environmental and operational conditions. Consideration is given to problems of redesigning electrical equipment to eliminate failures. *Product Engineering*, August, 1945, pages 537–540, 12 illus.

Treatment of High-Altitude Brushes by Application of Metallic Halides. Howard M. Elsey. The writer discusses the treatment of brushes with a suitable metallic halide to prevent wear under high-altitude conditions. It is stated that carbon, electrographitic, and metal-graphite brush grades all respond to such treatments, and that a great many nondeliquescent metallic iodides, bromides, chlorides, and fluorides have been tested and found to prevent brush dusting on the heavy-duty electric units of aircraft. A mechanism by which this class of chemical compound may react to maintain a satisfactory low-friction film on a commutator is proposed. *Electrical Engineering*, August, 1945, pages 576–579 (Transactions), 4 illus.

Selenium Power Rectifiers for A-C Aircraft Systems. Alvin L. Embry. It is noted that selenium rectifiers may be used in the two major types of electric systems used for large aircraft. These are (1) a system in which power is generated at variable frequency and converted to direct current; and (2) a system in which power is generated at substantially constant frequency and both a.c. and d.c. power are used.

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Rectifier units developed to supply 28.5-volt regulated d.c. power, which include stepdown transformers and voltage-regulating equipment, are described. The ratings vary from 100 to 800 amp. *Electrical Engineering*, August, 1945, pages 596–600 (Transactions), 12 illus.

Engines

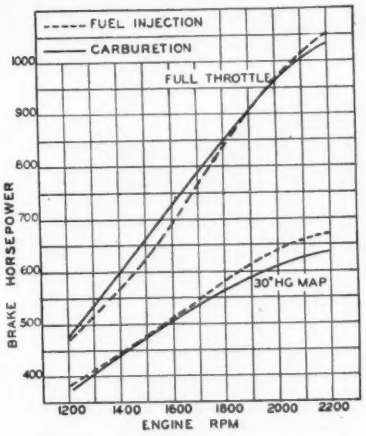
Fuel Injection for the Aircraft Engine. F. J. Wiegand and D. W. Meador. Part I of a four-part article about the application of fuel injection to aircraft engines reviews the history of the subject. The reader is given an insight into the problems accompanying the development of fuel metering methods. It was found that the importance of controlled metering to each combustion chamber increased as the size of the engine and the power rating increased. A description is given of tests that were carried out with Wright engines and the information that was gained through this research work. *Industrial Aviation*, August, 1945, pages 58–60, 62, 64, 98, 99, 16 illus.

New Resonance Jet Disclosures Show High Commercial Interest. Scholer Bangs. Comments are made regarding the possible future production of resonance-jet aircraft engines for commercial use. Particulars are given about a 5-oz. test model of a resonance-jet engine that is stated to deliver 2 lbs. of thrust. The midget jet, so far built only for wind-tunnel tests, employs a new and still restricted type of flutter valve, and runs on either gasoline or kerosene. *Aviation News*, August 13, 1945, page 22.

Bristol Centaurus. The arrangement, structural details, and features of the Bristol Centaurus engine are reviewed. Termed Britain's most powerful radial engine, the Centaurus is revealed as producing over 2,500 hp. The chief differences from its predecessor engine, the Hercules, are indicated. Schematic drawings illustrate the design of the Centaurus, its specifications are listed, and firms supplying major items for its construction are named. Components of this power plant which are surveyed include the cooling arrangements; cowling, fairing, and baffling arrangements; reduction gears; crankcase; sleeve drives; bearings; cylinders; pistons; blower and fuel-injection systems; supercharger; and gear boxes. *Flight*, July 5, 1945, pages 13–17, 7 illus.

The "Cirrus" Minor II Aero-Engine. Particulars are given about the Cirrus Minor II light aircraft engine, which is being produced by Blackburn Aircraft, Ltd. This engine, which is one of four models now being produced, is of the air-cooled, four-cylinder, in-line type. Construction features of the engine, which develops 100 b.hp., are described and some of its specifications are listed. *The Engineer*, July 27, 1945, pages 73, 74, 3 illus.; "Post-War Cirrus Engines," *Flight*, July 26, 1945, pages 93, 94, 2 illus.

The Best Precaution Against Damage by Fire. Some suggestions are noted for reducing the possibility of fires in the power plant while an aircraft is in flight. A system of fire drill developed by the Air Forces is outlined and recommended as the best precaution against engine fires. *Commercial Aviation*, July, 1945, page 68.



Photograph Courtesy Curtiss-Wright Corporation

A comparison of the power obtained on a nine-cylinder Wright Cyclone engine when using fuel injection and when using carburetion.

Flight Technique

Where Would You Land? The quick selection of an advantageous site for a forced landing is the subject of this article. General terrain and surface characteristics of different types of fields are interpreted and the pilot is advised as to the type of terrain best suited for an emergency landing and the best flight approach to use. The various types of fields are shown in illustrations of actual locations in eastern and midwestern parts of the United States. *Flying*, September, 1945, pages 35–42, 146, 8 illus.

Pilot's View. R. Dyrgalla. Indicating the visual limitations imposed upon the pilot by the structure of a fighter aircraft, the writer suggests a method for determining the relative position of the aircraft directly from the pilot's field of view. This is based upon the principle that by training the line of sight across given stations around the wing plan contour, figures in graticules painted on the wing at the critical stations will correspond, at given heights, to distances on the ground. *Flight*, July 19, 1945, pages 68a, 68b, 5 illus.

You Can't Go Wrong. R. G. Worcester. Pilots are advised on how to minimize the effects of accidents. Specific rules are laid down for the pilot to follow when a crash seems inevitable. *The Aeroplane*, August 3, 1945, page 125.

It Can Happen. Major Alva N. White. An Army flight instructor offers some suggestions for methods of preventing accidents that occur when a pilot attempts to turn back to the field after engine failure on the take-off. Analysis of one such accident leads to a discussion of two contributory factors, with advice on how to forestall their occurrence. The two factors are the engine misfiring on the take-off and failure to realize the consequences of a stall at low altitude. The writer recommends a system of teaching forced landings on the take-off as the main preventive. *Air Facts*, September, 1945, pages 82–85.

Dangers in Turning. A. Sipowicz Replies to criticisms of a previous article by the writer reviewing factors that endanger an airplane during a turn. The writer answers his critics point by point, giving mathematical bases for his conclusions. He claims that the entire discussion indicates the existence of an urgent necessity for extending theoretic instruction on the subject. *Flight*, July 26, 1945, pages 100, 101.

Fuels

Single-Cylinder Engine Tests of Substitute Motor Fuels. Donald B. Brooks. A report is made on a portion of an extensive investigation of substitute motor fuels conducted by the National Bureau of Standards for the U.S. Foreign Economic Administration. Single-cylinder-engine tests of nonhydrocarbon fuels and gasoline were conducted at fixed compression ratio and at the compression ratio for trace knock for each fuel. There was found to be no material differences in performance other than those associated with differences in heats of combustion and vaporization. All the nonhydrocarbon fuels could be operated at compression ratios higher than was permissible with the gasoline, with corresponding increases in power and thermal efficiency. *Journal of Research of the National Bureau of Standards*, July, 1945, pages 1–37, 26 illus.

Fuels for Jets. The problem of providing fuel for future reaction-propelled aircraft is reviewed. Consideration is given to fuel requirements for jet propulsion. It is stated that while reaction engines seem capable of operating efficiently on simple fuels, it is possible that greater efficiency can be obtained with special fuels. *Scientific American*, September, 1945, pages 162–164, 4 illus.

The Valuation of Better Fuels. Earle A. Ryder. In this article on the selection of aircraft fuels, the writer first discusses fuel quality in terms of the individual properties of gasoline which can be measured. The question of when the cost of a superior fuel can be justified is then considered. A graphic solution of this problem is given. Engine operating characteristics are reviewed from the standpoint of fitting the engine to the fuel so as to obtain the best performance possible from any given fuel. *SAE Journal*, August, 1945, pages 441–449 (Transactions), 12 illus.

Gliding and Soaring

Sailplane Dive-Brakes. J. A. Simpson. The design of dive brakes for sailplanes is discussed and past dive-brake developments are reviewed. It is

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stated that the only type of brake that has been found suitable for sailplane use is the spoiler flap. Two methods of operating spoiler flaps are described. The design requirements for dive brakes are analyzed. *Aeronautics*, August, 1945, pages 52–54, 8 illus.

Hydraulic Equipment

Hydraulics for Aircraft. R. H. Bound. In this extensive paper on aircraft hydraulic systems the writer confines his remarks to power-operated devices other than gun turrets. As a prelude to the main part of the article, the four means of operating aircraft controls, namely, pneumatic, mechanical, hydraulic, and electric, are reviewed.

The subject of hydraulic aircraft equipment and its design and performance is then discussed in detail. Consideration is given to installation layouts, hydraulic pumps and the effect of altitude on their performance, types of hydraulic valves for various services, landing-gear jack locking devices, and hydraulic glands. Brief remarks also are made about hydraulic fluids, emergency systems, and possible future developments in hydraulic equipment. A table gives the specifications of three types of pumps and another table contains figures for the comparative weights of low- and high-pressure hydraulic circuits for an airplane of 70,000 lbs. gross weight. Various performance curves for hydraulic equipment are included. *The Journal of The Royal Aeronautical Society*, July, 1945, pages 371–418, 60 illus.

Design Standards Offer Accumulative Savings. Richard M. Lord. The advantages of design standards are exemplified by a description of the method followed in providing a longer cycling life for a four-way hydraulic selector valve. The writer details the steps taken in selecting O-ring seals to replace the square seals originally used, referring to available graphs and tables based on Army-Navy specifications. The charts developed for this method are reproduced and the advantages arising from standardization are traced through the various processes of design and manufacture. *Machine Design*, August, 1945, pages 131, 132, 2 illus.

Inspection

Design Defects That Lead to Failures. An article based on the experience of the writer gained in the work of investigating and rectifying defects occurring in aircraft in service with the Royal Air Force. Deficiencies in the designing of details which have been found to lead to failures in service are described. The defects reported fall, roughly, into two classes, namely, structural and basic air-frame defects, and installation defects. Sections of the article are devoted to defects caused by bad design, manufacturing defects, and the reporting of defects. *Aircraft Engineering*, July, 1945, pages 209–213, 10 illus.

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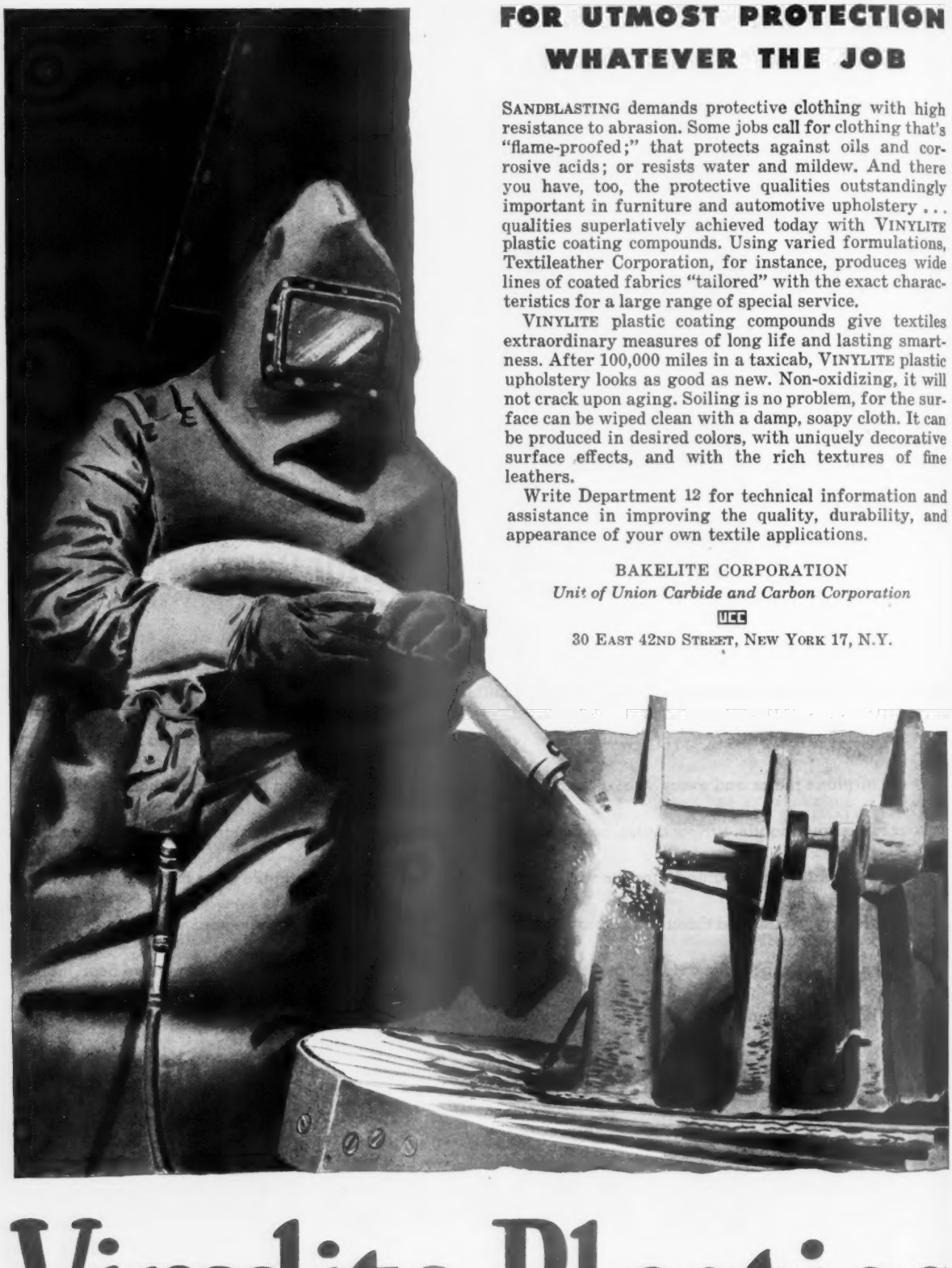

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Photo Grids for Checking Stretch and Flow of Metals. Frank Hewlett. Particulars are given about the photo-grid method of measuring the stretch and flow of metals during forming operations, as used at the Vultee Field Division of the Consolidated Vultee Aircraft Corporation. It is stated that the photo-grid is a pattern of fine grid lines applied by photographic means to a metal surface. If the metal is distorted under stress, the elastic grid pattern is also distorted in a corresponding manner and this distortion can be easily measured by scale or microscope over any part of the metal surface.. The techniques used to determine the strength and characteristics of parts are described and illustrated. *Automotive and Aviation Industries*, August 1, 1945, pages 38, 56, 58, 3 illus.

Instrument Flying

Instrument Rating in the RCAF. Robert Gole. The R.C.A.F.'s system of instrument ratings for pilots is outlined, with the requirements given for each of three types of instrument rating cards. In addition, the article contains data about the No. 1 Instrument Flying School of the R.C.A.F. and the courses studied there. *Canadian Aviation*, August, 1945, pages 71, 72, 112, 2 illus.

Instruments

Precision Determination of Weight with Resistance Wire Strain Gages. Arthur L. Thurston and Robert W. Cushman. A portable electric weighing kit for weighing aircraft is described. This kit was developed by the Cox & Stevens Aircraft Corporation to meet the need for weighing equipment that could be easily transported to the airplane. The equipment operates from the airplane's 24-volt battery or from a battery cart, giving assurance that a power supply is always available. The principle on which it operates is described. *Weight Engineering*, Summer, 1945, pages 40–43, 52, 5 illus.

A Pneumatic Piston-Ring Gage for Radial-Pressure Measurement. P. G. Exline. An instrument for indicating the radial pressure distribution of piston rings is described. It is explained that the piston ring is supported at 18 equally spaced points by flat-faced pins located around the circumference of a circle of the same size as the engine cylinder. The force exerted on each pin by the ring is measured by a self-balancing pneumatic device that simultaneously indicates all the forces on a row of 18 manometers. The rapidity with which the measurements can be made makes the instrument suitable for production inspection. *Transactions of the A.S.M.E.*, August, 1945, pages 491–500, 13 illus.

Engine Performance Indicator. L. J. Bordelon and O. W. Ehlers. Particulars are given about a device that registers the horsepower of an aircraft engine and gives immediate warnings of engine failure. This indicator was developed by the writers, who are engineers of the Consolidated Vultee Aircraft Corporation. The instrument's operation is based on the deflection of the engine mounts, the influences of which are transmitted mechanically and electrically and calibrated in terms of power and efficiency. It is stated to be the first instrument of its kind that is economical and efficient enough for installation in all production-model airplanes. *Industrial Aviation*, August, 1945, pages 38, 100, 4 illus.

A new development of G. M. Giannini & Company, Inc., a microtorque potentiometer requiring negligible force to operate, is shown coupled to a sensitive altimeter and can be used for remotely indicating altitude and to operate recorders and other flight test equipment.

Postwar Outlook for Aircraft Instruments. Part III. Esther H. Forbes. The third article in a series surveying the possible applications of wartime developments to postwar aircraft instrumentation is concerned with the products and the work of the Sperry Gyroscope Company, Inc., in this field. It is shown how this company's wartime-accelerated research in gyrostabilization and measurement of vibration will result in improved instruments for commercial and private aviation in the near future. With indications of their future possibilities, detailed descriptions are given of Sperry's gyro attitude indicator, Gyrosyn compass, Gyropilot, and detonation indicator. Plans for an automatic mixture control and a complete automatic power control are mentioned. *Southern Flight*, August, 1945, pages 38–40, 3 illus.

Speed-Range Indicator. An explanation is given of the purpose, design, operation, and functioning principles of the Baynes Speed Range Indicator. Offered as a mitigant for inadvertent stalling, this indicator comprises a normal air-speed indicator with an additional red pointer, concentric with the A.S.I. pointer, which is set at the known steady-flight stalling speed (engine on, flaps up). It is stated that this stalling-speed pointer is operated by a mechanism inside the instrument which will turn the pointer to a degree proportional to the square root of gravity acceleration, so that the correct stalling speed appropriate to the prevailing gravity acceleration will be shown on the dial and the margin between the two pointers will thus represent the speed range available between the prevailing stalling and flying speeds. *Flight*, July 12, 1945, pages 42, 43, 1 illus.

Landing Gear

Appreciation of Landing Problems. G. W. Drury. In Part I of a continued article on aircraft landing problems it is stated that, in its present state of development, the airplane provides a remarkable performance in every respect except that of landing and coming to rest. The quality of the landing depends entirely on the skill of the pilot, and without imposing additional burden on the human element further progress in aircraft performance would appear to be restricted by the limits of the landing gear. Factors that have tended to retard progress in landing-gear development are reviewed. Reference is made to departures from conventional landing-gear design, notably the efforts to provide a means of maintaining the wing incidence at the desired low angle to eliminate the "bounce" from increased lift in a three-point fast landing. It is stated that these departures have revealed, in use, certain undesirable tendencies that have prevented their general acceptance. The landing process is analyzed and consideration is given to brake arrangements, undercarriage arrangements, and landing-gear geometry. A system of linkage designed to overcome landing difficulties is proposed. *Aircraft Engineering*, July, 1945, pages 188–191, 5 illus.

Meteor Undercarriage. An explanation of how the Dowty levered-suspension undercarriage functions in the jet-propelled Meteor fighter. Solutions are noted to the special problems caused by the necessity for having the undercarriage legs shortened during retraction. *Flight*, August 2, 1945, page 116, 4 illus.

Maintenance

Engine Washing. Particulars are given about a paraffin washing unit that eliminates the carrying over of cresylic acid into the paraffin booth during the cleansing of aircraft engines. Manufactured by the Alfa-Laval Company, Ltd., the unit features a neutralization section applied to the main paraffin washing system which is so constructed as to prevent the cresylic acid from mixing with the paraffin. Use of this equipment is credited with not only protecting operators from acid burns but also with effecting a substantial saving of paraffin. *Aircraft Production*, August, 1945, pages 361, 362, 3 illus.

Production Control in Base Maintenance Shop. Lt. Budd Sills. It is noted that, in the summer of 1944, the Second Air Force, the largest of the continental air forces and first to train the Superfortress crews, sent a group of specially trained officers to

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No artist's dream, this giant clipper—she's already on order for Pan American and will be delivered as soon as conditions permit. Delayed by war, this continent-linker and other great new planes will nevertheless be better for the experience gained in the war—notably with improved precision instruments.

Designing and manufacturing precision parts and instruments for military planes, Kenyon alone has evolved scores of new processes and new or improved products, in line with its pledge to the aircraft industry to produce precision instruments in quantity and on time, *even if they have never been made before.*

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each of its approximately 40 bases for the purpose of installing an efficient production-control system. The writer describes the system they installed, which has been developed by the Production Control Section of the Aircraft Maintenance Branch. *Aviation Maintenance*, August, 1945, pages 44–47, 122, 8 illus.

Servicing Aircraft Fuel Systems. R. T. Hall. Pointers are offered on the servicing of the various components of aircraft fuel systems. The causes of fuel-system failures are discussed. Some of the more common troubles experienced with fuel systems and their causes are listed in chart form. *Aviation Service Magazine*, July-August, 1945, pages 14–17, 32, 34, 6 illus.

Hollow Steel Propeller Blade Repair. Fred Bryckta. Simple and effective procedures for the repair of hollow steel propeller blades are described. These procedures have been placed in operation at overseas air bases and also at some of the bases in the United States. *Aviation Maintenance*, August, 1945, pages 50–53, 118, 120, 14 illus.

Aircraft Hydraulic Equipment Maintenance. William L. Lewis. An outline is given of procedures for servicing hydraulic selector valves which will aid in obtaining prolonged, trouble-free operation. Conditions responsible for the failure of hydraulic systems are mentioned. Maintenance procedure that will aid in preventing failures is described. *Industrial Aviation*, August, 1945, pages 41, 42, 44, 103, 7 illus.

Planning the Postwar Overhaul Shop. E. F. Lindsley. With examples of currently successful medium and small plants, advice is given on how to select the location and arrange the layout of an aircraft overhaul shop. Specific recommendations are made for determining the site, size, and equipment of the shop. Special overhaul problems of which cognizance must be taken in planning the factory layout also are noted. In summary, one rule is cited as being of prime importance in setting up an overhaul business: to decide what the business scope will be, then accommodate the structure, equipment, and personnel to the business. *Aviation*, August, 1945, pages 160, 161, 256–260, 262, 2 illus.

Longer Life for Spark Plug Bushings. How Continental Air Lines, Inc., has multiplied the life of spark-plug bushings in radial air-cooled engine cylinders is reported. It is stated that this was accomplished by lining the solid aluminum-bronze bushings with noncorrosive stainless steel Heli-Coil inserts. The method of carrying out this operation is described. Figures are given on the increase in the hours of service obtained. *Aviation Maintenance*, August, 1945, pages 71, 132, 4 illus.

Braniff. Ed Packer. Special and standard equipment used by Braniff Airways, Inc., to provide speedy and efficient maintenance are noted. Particulars are given about a tilting stand used to hold an ignition manifold assembly in a convenient position, a chain hoist so mounted that it lifts heavy units with ease, and other shop equipment. *Aviation Service Magazine*, July-August, 1945, pages 18–22, 56, 13 illus.

All American Maintenance. How All-American Aviation, Inc., maintains the Stinson airplanes used in its air pickup service is described. Drawings show the layout of the overhaul and repair base at the Pittsburgh municipal airport. The equipment of the hangar and aircraft shop is listed. A description is given of the time-record card system developed to improve maintenance. *Aviation Maintenance*, August, 1945, pages 39–43, 11 illus.

Servicing 100,000,000 Horsepower. Chester S. Ricker. Information is supplied about the Ford aircraft-engine field service organization, which serves ten aircraft manufacturers and many airfield operational bases in the United States. The service is designed to make possible the incorporation of improvements in engines with a minimum of delay. *Wings*, August, 1945, pages 1670–1672, 7 illus.

Maintenance of the Boeing "Kaydet." Harold Zipp. Suggestions about the maintenance of Boeing Kaydet trainers, some of which are now being sold to the public, are offered to aid the prospective buyer. Information is given about the maintenance of the oil-type tail-wheel shock absorber, fuel-tank repairs, fuselage repairs, the servicing of central cables, and other items. *Aviation Maintenance*, August, 1945, pages 54–56, 122, 124, 126, 128, 8 illus.

Taming Hard-Shell Kirksite. John W. Davis. The writer describes how the Boeing Airplane Company has increased the life of Kirksite dies by the use of chromium plating. The dies are used in forming the tough stainless steel sheet for certain Superfortress parts. Information is given about the method of plating the dies and the way they are repaired after the working surfaces become cracked or chipped. *Wings*, August, 1945, page 1673, 1 illus.

Management

Gray-Matter Stimulator. D. J. Clow. A description is given of a quota cost-reduction plan that is stated to have brought results at plants of the Consolidated Vultee Aircraft Corporation. Both hourly paid and salaried employees participate in the plan. Yearly quotas are established more or less in relation to the number of employees in the department, but are adjusted with due regard to production forecasts and to past department performance. Weight is also given to inherent conditions that limit the possibilities of improvement in some departments in a way that they are not limited in others. After the quota is set, department heads must take whatever steps are necessary to meet the quota. Monthly charts indicate the progress made in cost reduction in each department. *Wings*, August, 1945, pages 1668, 1669, 2 illus.

Marketing

Make an Asset of a Nuisance. Ralph Gillian. Airport managers and operators are advised to encourage the enthusiasm of children who "hang around" an airport, as one method of promoting aviation in the minds of the public. Indicating the feasibility and advantages of such a course of action, the writer suggests specific ways in which the airport or flying school can stimulate and direct the interest of children in aviation as a means of "selling" their services to adults. *Western Flying*, August, 1945, pages 46, 47, 3 illus.

Materials

Low Melting Alloys as Production Aids. Walter C. Smith. The article describes a group of bismuth-base alloys developed to possess properties of extremely low melting temperatures, freedom from shrinkage on solidifying, strength, and hardness. The use of these alloys in aircraft-manufacturing processes for fixture work, forming dies, tube bending, and anchoring of dies and machine parts, as well as other applications in other industries, is described. Information is given about the metallurgic characteristics of the alloys and various specific applications. *Metals and Alloys*, August, 1945, pages 397–402, 7 illus.

Aging and Stretching 24ST Aluminum. Louis Ecker. A report is made on experiments that were conducted by North American Aviation, Inc., to determine what changes in mechanical properties can be obtained when aluminum alloy 24ST as-received sheet and extrusion are subjected to aging only, giving properties designated as 24ST81; and to a treatment involving 2 per cent stretching plus aging, resulting in 24ST84. The information obtained from three tests is analyzed, with descriptions of the specimens and the test procedures. *The Iron Age*, August 30, 1945, pages 360, 361, 1 illus.

Do Solid Magnesium Alloys Burn? Louis A. Carapella and William E. Shaw. A brief report gives the results of tests conducted on a number of commercial magnesium alloys to ascertain their behavior upon direct exposure to fire. The experiments indicated that solid magnesium alloys melt before burning. It is explained that magnesium dusts, like dusts from certain other metals, are burned easily because of the comparatively small amount of heat required to attain the ignition point. The presence of 0.001 per cent beryllium retards melting. The melting and ignition temperatures of certain magnesium alloys are listed. *Metals and Alloys*, August, 1945, pages 415, 416, 2 illus.

Analysis of Magnesium Application in German Aircraft and Equipment. F. A. Rappleyea. From a study of the use of forgings, sand castings, and die castings in German aircraft engines and radios, German applications of magnesium to aircraft components are reported and the merit of

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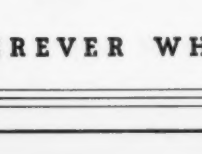

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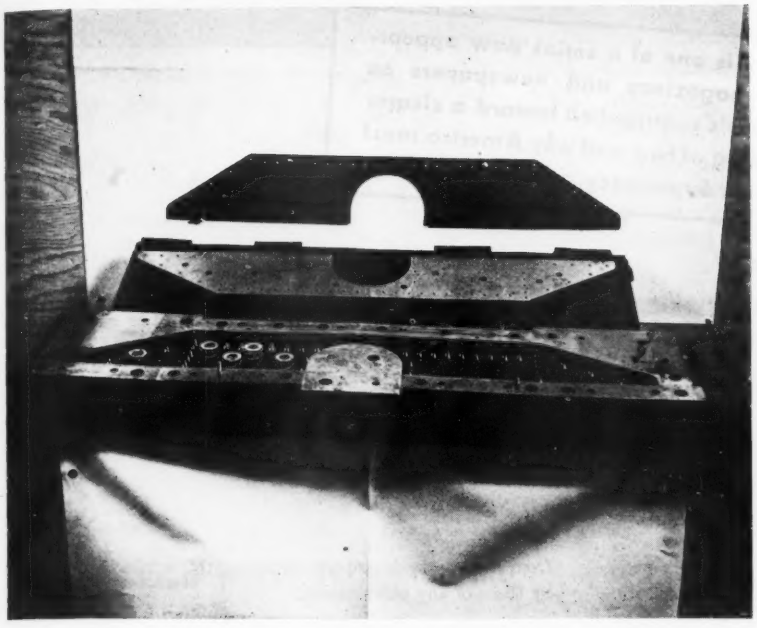

Photograph Courtesy Cerro de Pasco Copper Corporation

A stamping and piercing die for an aircraft part in which the punches are anchored in the die plate with Cerromatrix low melting temperature alloy.

these applications is evaluated. The engines under examination were the BMW-801D and the DB-601E; the radio, a Fungerrat. As summarized, the findings are: (1) Rather extensive use of forgings in magnesium alloys was made by the Germans and care was given to choice of an alloy for high-temperature applications. (2) Compositions used for magnesium did not differ materially from those in the United States, although usages of the alloys in various conditions differ. (3) No serious corrosion resulted in service even though the basic corrosion rates of the metals were greater than those of the alloys of the United States. (4) Design principles in the use of magnesium alloys by the Germans are similar to those used in the United States.

In addition to various illustrations, six tables supplement the article. These list the designation and composition of German alloys; number of articles for each alloy and condition; average mechanical properties and German specifications of magnesium-alloy castings; mechanical properties of forged Elektron alloys; average mechanical properties and German specifications of magnesium-alloy forgings; and the composition of articles examined. *Aviation*, August, 1945, pages 144–148, 19 illus.

Medicine

Phobias in Pilots. Major David B. Davis. The stated object of this article is to show the nature of the various phobias as they occur in pilots so that they may be recognized early and adequate psychiatric treatment instituted. Specific phobias studied are fear of high-altitude flying; flying over oceans or mountains; suppressed fear of flying; and fear of closed spaces. A case history exemplifying each phobia is given and three methods are advised for treating pilots who have phobias. General observation regarding such fears is that they are usually associated with an underlying and moderately severe anxiety state but at other times are the most apparent findings of a more far-reaching personality disorder such as psychosis. It is stated that all phobias thus far observed in the A.A.F. have been connected with specific situations. *The Military Surgeon*, August, 1945, pages 105–111.

Meteorology

Weather Conditions on a Flight Across the Tropical Storm of October 19, 1944 While in Northern Florida. Information is detailed about weather conditions encountered in a flight across the storm which passed over Florida on October 19, 1944. A B-17 aircraft commanded by Capt. Robert Buck, of T.W.A., was assigned to intercept this storm, fly through it, and observe the weather conditions and electrical phenomena. Conclusions regarding flying hazards and meteorologic conditions are summarized. *Bulletin of the American Meteorological Society*, June, 1945, pages 197–203, 7 illus.

The Atmosphere. G. R. Satchler. Information is given about the nature of the atmosphere. Charts show the layers into which the atmosphere is divided, how the ionized layers act as "mirrors" for radio waves, the origin of the half-light before sunrise and after sunset, and the change in the composition of the atmosphere at different heights. *Aeronautics*, August, 1945, pages 76, 79, 80, 7 illus.

Height of Stratus Ceilings at San Francisco Airport with Relation to Local Topography. H. C. Steffan and J. H. Morgan. The writers report the results of an investigation conducted to determine the ceilings of stratus clouds at the San Francisco airport and their relation to the topography of that locality. A chart shows the average height of stratus ceilings compared with the elevation of the terrain. Tables contain data on the relation of ceiling height to wind direction, and the frequency and average height of ceilings following 3 hours of average wind velocity from indicated directions. *Bulletin of the American Meteorological Society*, June, 1945, pages 204–206, 1 illus.

Naval Aviation

Analysis of Results. B. J. Hurren. For purposes of postwar budget decisions, the writer reviews questions in connection with the comparative usefulness of battleships and aircraft carriers in naval defense. He also investigates controversial issues as to whether maintaining a sizable force of carrier airplanes is preferable to maintaining a large number of bases for land-based aircraft. In emphasizing the fact that adequate air protection is necessary for all battleships, the point is brought out that warships apparently can be capsized by underwater explosions from near misses by heavy bombs. *Flight*, August 2, 1945, pages 113–115, 3 illus.

We Put the Flattops on the Night Shift. Comdr. Turner F. Caldwell, Jr., as told to Lt. Philip H. Gustafson. The article is concerned with the night operations of carrier-based planes. Included in the information is an account of how the night-flying program of carrier planes was developed and how it operates; descriptions of the special take-off, landing, and flying techniques employed by naval fighter planes operating at night; and an outline of the special training required for pilots of such planes. *The Saturday Evening Post*, August 11, 1945, pages 26, 27, 41, 42, 3 illus.

Paints and Coatings

Restoration of Aircraft Finishes. C. R. Smedley and George E. Wilson. In a two-part article, instructions are given in the proper techniques of aircraft finishing. The first part of the article deals with the matching of paint colors in a patching job; the second, with various methods of finishing the plywood and fabric surfaces of primary trainers. In the latter portion of the article, attention is called particularly to the difference in handling the all-plywood surface as against the plywood-fabric combination. *Aero Digest*, August 15, 1945, pages 111, 138, 1 illus.

This advertisement is one of a series now appearing in national magazines and newspapers as Consolidated Vultee's contribution toward a clearer public understanding of how and why America must retain its present Air Supremacy, even after Victory.

Never forget the A B C of

THE NATION that "freezes" the design of its military planes can write off its Air Force as inferior and second-rate.

And, before too long, that nation can write off its Air Force altogether . . . for no second-rate Air Force can long control enemy skies, or even its own.

The Luftwaffe, for example, was beaten because of two things: first, because of overwhelming Allied aircraft *production* . . . and second, because Germany was too late in learning the ABC of Air Power . . .

What is the ABC of Air Power?

The ABC of Air Power is a technique introduced in this war by the Army and Navy and the American aircraft industry.

In simple language it is the technique of making frequent changes in design, during mass production, so that the planes we send into combat *tomorrow* are consistently better than those in combat *today*.

Because America has in this way kept its plane designs fluid, instead of freezing them, our Army and Navy Air Forces, from week to week and month to month, cannot be matched by those of any other nation.

Here's how it works

A company such as Consolidated Vultee starts mass production of a long-range super-bomber—the B-32 Dominator, let us say . . .

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Then come more changes . . . and the B-32C is born. This goes on, right down through the alphabet.

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This miracle of constant improvement during mass production—often accomplished **while stopping the assembly lines only momentarily**—sounds like an ideal way to keep an Air Force at peak efficiency. And it is.

But there's another factor to be reckoned with—a factor most people didn't know about in prewar years, or simply overlooked.

That factor is TIME . . . the length of time that elapses between the day a new plane is designed and the day the first model goes into production. And *that* is the joker in Air Power.

The fact of the matter is this: **It takes anywhere from 3 to 7 years for a war plane to progress from drawing board to combat action.**

We were caught napping when World War II broke out, because the nation as a whole was unaware of this joker in Air Power.

But, thanks to a few far-sighted Army and Navy officers, and a few members of the aircraft industry itself, we were not caught *totally* unprepared.

Air Power!

A lesson worth remembering

Long before Pearl Harbor, it was obvious that if we ever did go to war against Japan it would be a war in which mobile, floating airfields—flat-tops—would play a dominant part.

So, starting as far back as 1927, the Navy and the aircraft industry began to experiment with carrier-based dive bombers. In 1939—**12 years later**—the plane born of these experiments was approved for mass production. **But even then, it wasn't ready for combat until 1943!**

Similarly, our finest Navy fighter planes saw combat action for the first time **2 years or more after Pearl Harbor** — even though they had been in various stages of development and undergoing test flights long before Japan struck.

It must be clear to every thinking person that when it takes so many heart-breaking months and years to perfect a plane for combat, America must never again invite disaster by lagging behind **any** nation in aeronautical research and development.

Air Power is Peace Power

Today, no spot on earth is more than 60 hours' flying time from your local airport.

In a world so small, there can be no peace, no security, unless we are prepared to defend ourselves against attack from the air.

That is why constant and continuing **aeronautical research and development** – on the part of the Army, the Navy, and the aircraft industry – is an insurance policy on the life of the nation.

And we must not let a single premium lapse!

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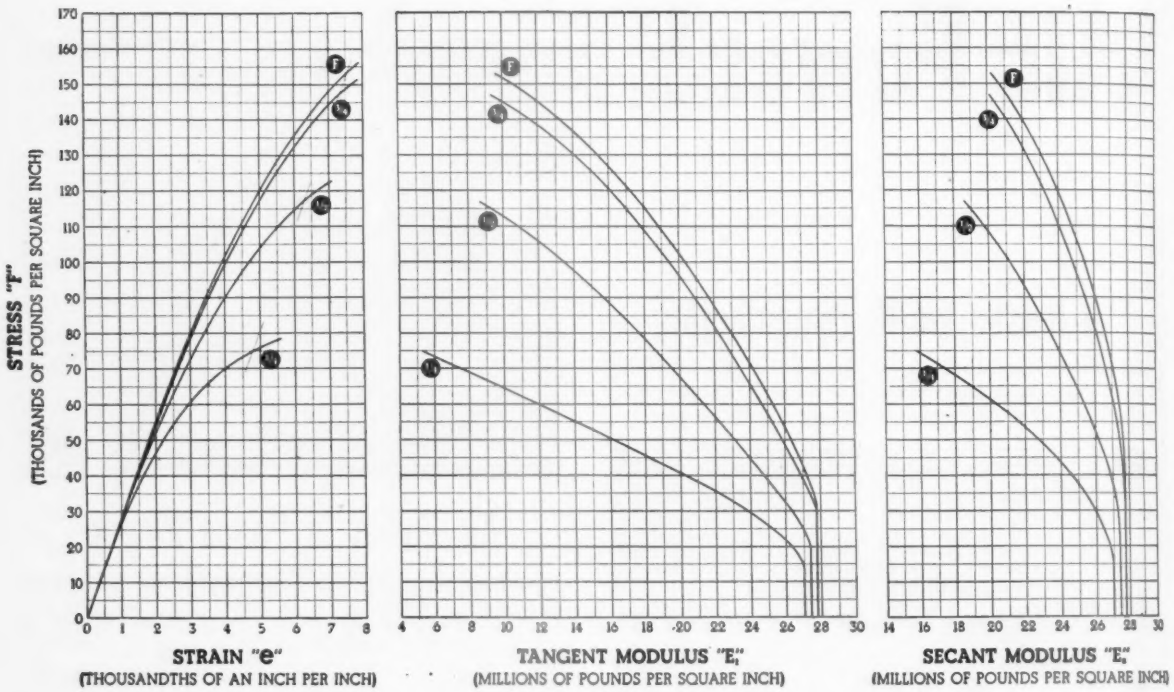
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These curves show the tensile properties of ARMCO High Tensile Stainless Steel Sheets from tests made on longitudinal specimens as cold rolled. They are reproduced from a practical new handbook that contains compression and tension values of high strength stainless for the complete useful range.

These data give the stress-analyst and designer the information needed to proportion stronger, lighter structural parts with *less* stainless. Construction of aircraft and other light-weight structures demands adequate knowledge of the compressive strengths that can be expected from the materials you use.

Besides the detailed values for stainless, the handbook covers some fundamental concepts of design theory to be considered when using stainless steels at the high stress levels where they are most effective. Mechanical properties of the stainless steels and derived design data are also included in the book.

		¼ Hard	½ Hard	¾ Hard	Full Hard
Ultimate Strength—thousands of lb. per sq. in.	F_{tu}	133	162	183	187
Yield Strength at 0.2% Offset—thousands of lb. per sq. in.	F_{ty}	75	117	147	153
Proportional Limit at 0.01% Offset—thousands of lb. per sq. in.	F_{tp}	35	49	59	61
Initial Modulus of Elasticity—millions of lb. per sq. in.	E_o	27.0	27.5	28.0	28.0
Elongation—per cent in 2 in.		46	37	31	29

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Personalities

Trans-Canada Tommy. Frank H. Ellis. A biographic article about G. A. Thompson. Thompson's career is traced through his activities as a pilot and instructor with the Royal Flying Corps; as organizer of the Canadian Aircraft Company; as pioneer, record-setting pilot in Canada's Northwest; and superintendent of Western Canada Airways, Canadian Airways Ltd., and Canadian Pacific Air Lines. *Canadian Aviation*, August, 1945, pages 54–56, 118, 120, 9 illus.

Photography

OSC-1 Air Survey Camera. Information is given about the design, operation, merits, and cost of the O.S.C. Mk. 1 camera developed by the Williamson Company for air mapping. Supplementing these details is a discussion regarding the general development of photogrammetry in Britain, requirements for air surveys, and the comparative qualities of German and British photogrammetric cameras. *Flight*, Ju y 26, 1945, pages 98, 99, 4 illus.; "A New Air Survey Camera," *The Aeroplane*, July 27, 1945, page 96, 5 illus.

Plastics and Plywood

Infra-Red Heating. T. A. Roberts and C. J. Hadderfield. Equipment and techniques are described for the preheating of synthetic resinous molding materials by infrared radiation. The information given includes details about units for preheating plastic preforms, plastic pellets, and plastic powders. Advantages of these infrared heating applications are indicated and some of the molding problems that this type of radiation helps to overcome are outlined. All the equipment reviewed is the product of the Chandos Engineering Company, Ltd. *Aircraft Production*, August, 1945, pages 359, 360, 2 illus.

Many Uses of Plastics in Army Transport Plane. To obtain an idea of how aircraft companies will utilize plastics in future commercial airplanes, a brief study is made of plastic applications in the C-69 Constellation. It is stated that this is one of the many Army transports that can enter immediately into commercial flight when military needs are satisfied. Information is given about the use in this transport plane of extruded moldings, plastic overlaid veneers for walls and trim, vinyl-impregnated fabrics over glass-cloth insulation, etc. *Pacific Plastics*, August, 1945, pages 21–23, 6 illus.

Air Ducts on the B-29. The application of glass cloth impregnated with one of the newest of the alkyl family of contact resins to the manufacture of defroster ducts for the B-29 is described. It is explained that these parts formerly were made of aluminum, formed to an intricate pattern demanded by the design of the fuselage. Information is given about the current production method employed by a Detroit firm in the manufacture of the air ducts. This method embodies the use of quickly made wood patterns and plaster molds to form an aluminum mold in which is cast a metal core or wrapping base for the duct. From the wrapping base to the final surface finish the process is one in which plastics are applied in a new way. *Modern Plastics*, August, 1945, pages 136–140, 11 illus.

Transparent Plastic Enclosure. Gilbert C. Close. Instructions are given for the care and repair of acrylic plastic parts in aircraft. In order to keep bubble canopies, cabin enclosures, windshields, and instrument covers in perfect optical and physical condition, procedures are suggested for six definite stages of maintenance. These stages cover (1) protection; (2) cleaning; (3) cementing; (4) repairing; (5) sanding and polishing; (6) handling and mounting. *Western Flying*, August, 1945, pages 44, 45, 72, 74, 5 illus.

Vacuum Moulding. The writer outlines some of the advantages of the vacuum forming method of molding aircraft parts from transparent acrylic resin sheet. He describes the fabrication of an exceptionally large unit of this material for a Halifax bomber by means of the vacuum molding process. This unit is a scanner, which is made of Perspex. *British Plastics*, July, 1945, pages 277–278A, 5 illus.

Elastic Properties of Plastic Materials. John Delmonte. It is stated that the average plastic material does not have a sharp break in the stress-strain curve to denote the yield strength or elastic limit. Uusually experience or even conjecture is the guide to determining working stresses. An advance toward the solution of this problem is made by the writer, who describes beam-deflection methods of obtaining elastic-limit stress data which have special significance in practical applications. A curve-deviation method is suggested by means of which elastic limits are more accurately determined than by conventional stress-strain technique. *Transactions of the A.S.M.E.*, August, 1945, pages 477–481, 10 illus.

Plastics for Postwar Car and Plane. G. M. Kuettel. Present and future applications of plastics in planes and automobile equipment are assayed. It is stated that virtually thousands of plastics are possible theoretically but that only a score of these possibilities have achieved substantial success. The characteristics and advantages of some of the successful plastics are outlined. Sections of the article discuss the acrylics and their applications in airport lighting, headlight lenses, and working models; polyvinyl butyral resin; and polythene. The general properties of some typical commercial plastics are given in tabular form. *Automotive and Aviation Industries*, August 15, 1945, pages 34–36, 88, 90, 92, 6 illus.

Nylon Armor Protects Navy Plane Crews. Lt. Robert Temple. A description is given of the plastic armor used for the protection of flying personnel, which has been in production under the direction of the Navy's Bureau of Aeronautics. Nylon armor is somewhat like a baseball catcher's body protector except that it has a back as well as a front. It is explained that this plastic, flexible armor consists of a multiplicity of plies of heavy nylon fabric stitched together. Information is given about flexible flak vests and about curtains used in the plane to protect the crew members from flak. *Modern Plastics*, August, 1945, pages 102A, 102B, 105, 5 illus.

Production

Fairey Barracuda. Part II. Wilfred E. Goff. Concluding half of a two-part study of the production methods involved in the manufacture of the Fairey Barracuda. Following a review in the first installment of the building procedures for the center section and mainplanes of this Fleet Air Arm torpedo bomber, Part II is concerned with the manufacture of the remaining sections of the fuselage, the undercarriage torsion box, and some of the smaller components.

Drawings and photographs illustrate the processes and machinery described. Details regarding the fabrication and assembly of the components are imparted under headings of main fuselage fixture, cockpit section, engine mounting, torsion box, fuselage assembly, tail unit, aileron, and final assembly. *Aircraft Production*, August, 1945, pages 364–376, 34 illus.

Car Production Principles as Applied to Aircraft: Major Assembly Fixtures—Conveyors and Line Assembly. B. G. L. Jackman. The utilization of the facilities of automobile manufacturers for the production of aircraft components is further discussed in this article, which is one of a series. The peculiarities of different major components of an aircraft are briefly outlined. Information is given about the most suitable type of jig for each type of unit. The advantages to be gained from line assembly when applied to aircraft and their major components are enumerated. Types of conveyers are reviewed. It is concluded that most aircraft units are adaptable to a moving-line system of assembly for at least the fitting-out stages and often for the structure assembly also. *Sheet Metal Industries*, August, 1945, pages 1403–1406, 1411–1416, 20 illus.

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FOUNDED IN 1926, Breeze Corporations was a vital factor in the development of clearer communications for commercial, as well as military aviation. The Breeze prewar reputation as a manufacturer of such precision items as Radio Ignition Shielding, Flexible Conduit and Electrical Connectors, was further enhanced during the war years by the performance of these products and of Breeze Cartridge Engine Starters, Tab Controls, Armor Plate and countless other Breeze specialties — all of which made marked contributions to the winning of Final Victory.

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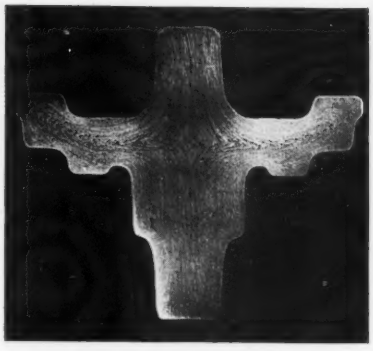
The Case for the Specialist Firm. Ian M. Hamer. A plea is made for postwar government encouragement and support of Canadian firms specializing in the manufacture of aircraft components and accessories. In urging such a program, the writer explains why it is a necessity in Canada where the aviation industry is an "unbalanced" one composed mainly of companies engaged in aircraft production solely as a war measure. He also indicates the importance of maintaining the Canadian aviation industry on a scale far exceeding the one attained prior to the war. Conditions which, in the writer's opinion, a specialist should meet in order to qualify for specific government and industry consideration are outlined. As an illustration of the type of "specialist" company discussed, the aviation-production activities of Dowty Equipment (Canada) Ltd. are reviewed. *Commercial Aviation*, July, 1945, pages 22–25, 8 illus.

Fabricating Steel Tubing. C. E. Booth. The writer describes improvements in the methods of fabricating tubular steel aircraft structures which have resulted from the use of new machines, conveyers, and simplified operations. Particulars are given about a method of milling tubing which makes it possible to maintain the close joint tolerances required in order to make satisfactory welds. *Industrial Aviation*, August, 1945, pages 45, 46, 48, 93, 5 illus.

Furnaces and Heat Treatment for Permanent Mold Magnesium Castings. A. V. Keller. The building and operation of a furnace for the heat-treatment of permanent mold magnesium-alloy castings are detailed. Some of the causes contributing to substandard castings are listed. Sections of the article discuss selection of the equipment, the design of the oven, and the oven load. It is stated that sulphur is not used to provide an inert atmosphere because it causes rapid deterioration of the oven structure. The reducing atmosphere is maintained through manipulation of the burner and oven atmosphere. *Modern Metals*, August, 1945, pages 20, 21, 23, 2 illus.

Out-of-the-Ordinary Internal Grinding Set-Ups. Carl G. Nordmark. Unusual machine setups for internal grinding are described and illustrated. Some are designed to solve difficult grinding problems and others to secure faster or more accurate production. Among the setups described is one employed for grinding 24 holes, accurately spaced, in an aircraft accessory-drive assembly, and one for internal grinding of an aircraft landing-gear strut cylinder. *Machinery*, August, 1945, pages 152–156, 10 illus.

Magnesium Machining. Gerald E. Stedman. A survey of the methods used for the machining of the support assembly for the unusually wide landing gear of the P-51. How the machining of the intricate 40-lb. magnesium-alloy casting has been simplified is described. Various steps in the machining operations are illustrated. *Industrial Aviation*, August, 1945, pages 66–68, 100, 101, 11 illus.



Photograph Courtesy Wyman-Gordon Company

An etched section of a small aircraft-engine gear forging indicates the careful preparation of stock in the preliminary forging operations.

Quality Must Be Built—All Along the Line. L. R. Barrett. The writer reports methods of statistical control installed in the drop-hammer department of Bell Aircraft Corporation, which have resulted in the production of improved aircraft parts. The methods described were developed through a statistical study which was started in 1944. *Wings*, August, 1945, pages 1665–1667, 2 illus.

Hot Forming Magnesium Alloy Sheet. J. B. West. The use of electrically heated tools in the hot forming of magnesium-alloy sheet is discussed. Data are supplied on temperatures, heating methods, types of forming, gage of material, and satisfactory lubricants. *The Iron Age*, August 16, 1945, pages 56–61, 12 illus.

Dimensioning of Rough Forgings to Assure Metal for Finishing. Frank M. Mallett. The writer considers the problem of determining the nominal dimensions and tolerances on forgings so that any combination of tolerances will leave enough material for machining. A method of approach is suggested and a general solution of a typical problem is given. *Product Engineering*, August, 1945, pages 552, 553, 2 illus.

Propellers

New de Havilland Airscrews. Characteristics of three propellers manufactured by The de Havilland Aircraft Company, Ltd., are surveyed briefly. Two of the propellers are new, while the third is a smaller and modified version of a type used in the early days of the war. One of the new propellers is a two-blade, variable-pitch, manually operated model for powers up to 200 hp. The other is a three-bladed metal, hydromatic constant-speed, feathering and braking propeller, scheduled to be fitted to the new de Havilland Dove feederline airplane. The improved propeller is a two-blade, hydraulically actuated type, suitable for powers from 200 hp. to 300 hp. *Flight*, July 19, 1945, page 66, 3 illus.

Lightplane Propeller Development. Part I. John D. Waugh. The development of automatic and controllable propellers for light planes is studied. Reference is made to the relatively scant attention that has been given to the propeller, the action of which largely determines the performance, efficiency, and versatility of the light plane. A specific airplane—the Johnson Rocket—is used to illustrate the effects of propeller design on aircraft performance. The requirements for controllable-pitch propellers for light planes are outlined. *Industrial Aviation*, August, 1945, pages 27–29, 31, 32, 101, 102, 12 illus.

Details of the Piaggio Propeller Used on Italian Warplanes. John D. Waugh. An analysis of the design, construction, and operation of the Piaggio controllable-pitch propeller. The propeller assembly described and illustrated is an improved design, removed from a 1942 model Macchi MC-200 a.2 fitted with a Fiat A-74 engine rated at 840 hp. Among the particulars given are details relating to the method of obtaining pitch change through propeller rotation; reduction ratio; gear box and gear system; bearings; various hub components; blades; blade material; blade retention system; clutch housing; clutch and governor assemblies; and detachable spinner. *Aero Digest*, August 1, 1945, pages 57–59, 160, 162, 163, 14 illus.

Wooden Propeller Blades. Robert C. Wilson. Techniques based upon methods developed by the Army Air Forces are advised for the maintenance and repair of wooden propeller blades. The prescribed procedures relate to the application of inlays for major damages; the restoration of hub faces that have been crushed; repair and replacement of damaged tips; and repair of cracks, swells, dents, loose seams, nicks, and bends in the metal portions of the propeller. Steps for reconditioning the propeller and applying new fabric are outlined. *Western Flying*, August, 1945, pages 40, 41, 78, 80, 82, 13 illus.

Radio

Two-Way Communication. S. S. Stevens. Functions, principles, and trends of two-way aircraft radio communication are reviewed in this first of a series of six articles dealing with the technical aspects of radio and communication in Canadian air transport. The discussion is divided into two categories, short-range communication and long-range communication. Advantages of Very High Frequencies (V.H.F.) for short-range communication are demonstrated, while it is shown why High Frequencies (H.F.) are most suitable for long-range communication. With reference to short-range communication, the following engineering factors are examined: choice of frequency channels, polarization, modulation, channel separation, frequency, weight, power, power output, guard frequencies, and control. In the field of long-range communication, the factors considered are modulation, channel separation, frequencies, receivers, weight, power, power

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output, receiver sensitivity, stability, and types of communication. *Commercial Aviation*, July, 1945, pages 34, 37.

A New Type of Automatic Radio Direction Finder. C. C. Pine. Details are given about a system of automatic radio direction finding that operates on the principle of effectively converting the radio-frequency currents developed in two low-impedance loops into direct currents of proportional amplitude and having the same relative polarity as the instantaneous values of the radio-frequency currents developed. By utilizing the two fixed loops in space quadrature, direct currents are obtained which can be applied to an indicating meter or cathode-ray tube in such a manner as to give a continuous visual indication of the angle, in the horizontal plane, at which an incident wave is striking the loop assembly. *Proceedings of the I.R.E.*, August, 1945, pages 522–527, 7 illus.

Reaction Propulsion

The Long-Range German Rocket V2. Additional information about the V-2 rocket is given in this article, which is based on a communication from the British Ministry of Aircraft Production. The V-1 flying bomb and the V-2 rocket are compared. It is explained that the V-1 is a pilotless airplane that is propelled by a simple internal-combustion unit and costs no more than a light car, while the V-2 is a rocket of such complicated construction that its use may be compared with the expenditure of a Spitfire fighter for each ton of bombs delivered. Particulars about the V-2 rocket are given in sections dealing with the warhead, control compartment, fuel tanks, turbine and fuel pump units, combustion chamber, and control surfaces. *The Engineer*, July 27, 1945, pages 77, 78, 4 illus.; "Authentic Details of the A-4 Rocket (V. 2)," *The Aeroplane*, July 27, 1945, page 95.

Flight by Jet. Squadron Leader R. C. Tiplady. In addition to recording Canada's contributions to, and activities on behalf of, jet engine development, this article also outlines Canada's present position with regard to jet propulsion. Factors of Canadian participation in jet development featured in the article are Canada's cooperation with England in low-temperature testing and the formation of Turbo-Research Ltd., a Canadian Crown Company organized for the purpose of carrying on experimental and scientific work on the gas-turbine type of prime mover. Excerpts from a press release issued by the British Air Ministry News Service give an idea of the operations of jet aircraft. *Canadian Aviation*, August, 1945, pages 48, 49, 116, 3 illus.

Aeronautical Supremacy Demands Jet and Rocket Research. Part II. Roy Healy. Concluding half of a two-part article stressing the importance of rocket research and indicating future trends of development in this branch of aeronautics. Part II is concerned with the need for continued study to develop defensive and offensive rocket weapons. It also discusses possible peacetime applications for power derived from reaction propulsion. The present status of development and future potentialities of the following are considered: chemical and incendiary rockets; long-range rocket and jet bombs; countermeasures against rocket projectiles; liquid-fuel rocket motors; thermal jet power; and rocket exploration of the upper atmosphere at heights of 100 miles and more. *Aviation*, August, 1945, pages 149–151, 4 illus.

Reconversion

Procedures for Contract Termination. War contractors and subcontractors are advised how they can facilitate settlement of their termination claims. Definite procedures to be followed are outlined. Among the suggestions are recommendations for efficient accounting methods and for methods of aiding speedy plant clearance. Forms to be used in the settlement of contracts are illustrated and a tabulation shows which costs may be included in the claims and which may not. Obstacles that the contractor must overcome in handling each termination case are summarized as (1) failure to assign and train termination personnel and give them full authority; (2) failure to explore the possibility of a pretermination settlement agreement; (3) failure to arrange for any needed interim financing; (4) failure to allocate material to specific contracts; (5) failure to take inventory promptly; (6) failure to obtain and settle subcontractor's claims promptly; (7) failure to present termination claims promptly and on the standard proposal forms. *Aero Digest*, August 1, 1945, pages 33–35, 2 illus.

Mosquito Goes Three Ways. R. C. Macinnes. An account of how manufacturing operations for Mosquito aircraft fuselages were transferred from General Motors of Canada, Ltd., to three other companies so as to enable the Cockshutt Moulded Aircraft, Central Aircraft, and Clyde Aircraft companies to continue the production of aircraft components while General Motors prepared part of its plant for the manufacture of civilian goods. It is explained how the transfer took place without interrupting the production flow of the fuselages, the three companies commencing manufacture while the General Motors assembly line was still in operation. Equipment, fabrication methods, and assembly procedures established by General Motors and transferred to the other three firms are surveyed. As related, the arrangement provided for the Cockshutt company to produce the fuselage shells complete with the primary paint operation, the Clyde company to make the canopies, and the Central company to do the assembly work. *Commercial Aviation*, July, 1945, pages 38, 40, 42, 107, 7 illus.

Programming Contract Termination Training. Brief notes are given about a training program offered by the armed services to assist war contractors in preparing for termination or adjustment of their Government contracts. The program consists of a series of 4-hour courses on termination procedures and forms, given under the guidance of 21 Termination Coordination Committees located in key production areas. Locations of the committees are listed in the article. *Aero Digest*, August 1, 1945, pages 36, 37, 6 illus.

When Their Men—and Women Come Home. Herbert Chase. An outline is given of plans now in effect at Johns-Manville Corporation plants which are designed to give returning veterans a cordial reception and to fit them into their old jobs. *Wings*, August, 1945, pages 1674, 1675, 1 illus.

Reconversion of Equipment

Reconditioning of Surplus Trainers. William L. Blythe. Based upon the experience of Southern Airways, Inc., in the reconditioning of surplus military light airplanes for civilian use, this article outlines major modification requirements and average costs to the purchaser for such work. Costs and requirements are listed for the PT-17, PT-19, PT-22, and L-Type aircraft. The article also cautions the prospective buyer of Defense Plant Corporation aircraft that, in many cases, there are supplementary expenses in addition to the modification costs for bringing the airplane to the standards necessary for the C.A.A. to license it as airworthy. *Aero Digest*, August 15, 1945, pages 69, 70, 134, 2 illus.

Converting Aeronca L-3's. T. A. Strawser. The writer describes how several Aeronca airplanes that had been built to Army L-3 specifications were converted for civilian use at the Municipal Airport, Springfield, Ohio. Inspection operations that were carried out before the conversion was started are described. *Aviation Maintenance*, August, 1945, pages 74, 75, 132, 1 illus.

Rotating Wing Aircraft

Helicopter's Dual Rotors Disposed in Tandem Offer Certain Advantages. Specifications and descriptive data are given for the two models of the Heliplane now being built by Hartwig Aircraft. A helicopter having dual rotors disposed in tandem with the rear rotor above the forward rotor, the Heliplane is reported to dispense with the use of a tail rotor because of the counterrotation.

While one model of this helicopter is a two-seater and the other a five-seater, both are said to be almost identical in general appearance, with the exception that the larger model will have wheels instead of pontoons for its landing gear. In addition to the elimination of the tail rotor, other design objectives of the Heliplane are (1) automatic lift control; (2) an automatic device that adjusts the lift and relieves the

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pilot of the task of adjusting the rotor; (3) a simplified operational control unit, which amounts to a steering wheel on a control stick; (4) a new type of rotor blade that is said to remove present limitations on blade length and rotor diameter. *Aero Digest*, August 1, 1945, page 84, 1 illus.

Basic Factors of Helicopter Design. R. H. Prewitt. Information regarding basic factors involved in the design of helicopters is supplied in simplified form. An outline is given of a method of designing a helicopter which, it is stated, will provide optimum efficiency for both hovering and cruising flight. The formulas are given for computing power loading, figure of merit, maximum lift, blade dimensions, and other factors, as well as graphs and tables based on the figures. *Industrial Aviation*, August, 1945, pages 70, 71, 102, 4 illus.

Principles of Rotary Wing Aircraft. Part V. Alexander Klemin. Vertical descent with power, or autorotation, is considered in the fifth part of a serial article. Formulas are given for determining when the blade is in autorotative equilibrium. It is shown why decrease in blade pitch is desirable in autorotative descent and what happens in the event of engine failure, while climbing or hovering is explained. Tests are stated to have demonstrated that coefficients of resistance greater than 2 have been attained by well-designed rotors when in nonpowered descent. The writer shows why the simple momentum theory does not apply, as a rule, to vertical descent of a rotor, giving two examples and commenting on them. He then deals concisely with the four different states of flow, which are listed as (1) windmill brake condition, (2) turbulent state, (3) vortex ring state, and (4) propeller state, obtaining convenient expressions for the disc-flow ratio and for other factors under stipulated general rules. Examples illustrative of the ideas expressed and of the Glauert empirical curve are given, and three problems are offered for solution by the reader. *Aero Digest*, August 1, 1945, pages 87, 88, 91, 92, 143, 144, 147, 148, 3 illus.

Helicopter - Blade Geometry. George F. Bush. A method for analyzing the space geometry of a helicopter blade combines analytic geometry and graphic representation for determining the true angle of the blade with respect to the plane of rotation. It is offered as a simplification of the mathematical difficulties involved where the motion about the flapping hinge is combined with the lag about the drag hinge. The method produces various fundamental, general trigonometric equations, one of the simplest of which is that for the lag angle. The article gives a description of this general method with a specific application to the determination of the general equation for the lag angle. The writer explains the solution and derives the required equation. He states that other general equations, such as that for the blade angle, can be obtained in a similar manner. *Aero Digest*, August 1, 1945, pages 97, 98, 140, 4 illus.

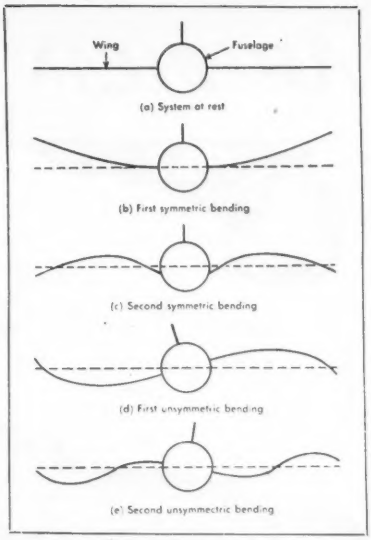

Illustration Courtesy Republic Aviation Corporation

Typical airplane wing fuselage bending modes schematically illustrated.

Stress Analysis

Some Notes on Vibration Analysis. R. J. Manley. The writer states that theoretic papers on vibration most commonly describe new methods of analysis and calculation. He states that it is becoming increasingly difficult for the general engineer, who has neither the time nor the inclination to follow in great detail the development of all the specialized subjects, of which vibration study is only one, to retain in his mind a clear picture of the general strategy applicable to the attack on vibration problems and to fit into this strategic scheme the tactical operations represented by the new methods. He then presents an outline of the fundamental process of solution of vibration problems, so far as this is affected by calculation. *The Journal of The Royal Aeronautical Society*, July, 1945, pages 419–426, 2 illus.

Photo-Elasticity and Design Problems. R. B. Heywood. Photoelasticity is described as an optical method of measuring stress. In this first installment of the article, an outline is given of the technique of stress measurement by photoelastic methods. Reference is made to the older photoelastic method of determining the stresses, which is gradually becoming obsolete, in which use is made of a source of white light and a celluloid model. The modern technique, in which use is made of monochromatic light in conjunction with Bakelite, is described. Information is given about the determination of stress from fringes. How difficulties caused by edge stresses and the time-edge effect have been met is described. *Aircraft Engineering*, July, 1945, pages 195, 196, 3 illus.

Influence Coefficients in Stress and Vibration Analysis. Robert Rosenbaum and Robert H. Scanlan. Methods of stress and vibration analysis are set forth. A description is given of a relatively simple method of attacking the problem of torque load distribution presented by a two-spar wing with large cutouts. The results of an interaction analysis are applied to the calculation of torsion-influence coefficients for a two-spar wing with torque box. Other sections of the article deal with uncoupled natural frequency calculations, aileron reversal, and torsional divergence. *Industrial Aviation*, August, 1945, pages 49, 50, 52, 54–56, 94, 95, 4 illus.

Elasticity Problem of the Statically Indeterminate Rectangular Frame. Dimitry E. Olshevsky. Expressions and methods are presented for finding the elasticity of a statically indeterminate frame at the point of application of a single force load, deflections being measured with reference to the supports. The case treated is that of a continuous rectangular frame, supported at two points lying in one axis of symmetry and loaded by a single force applied in the plane of the frame at a point lying in the other axis of symmetry.

Practical applications are encountered in the design of precisely balanced suspensions using the rectangular frame as a load-carrying structure, such as gyroscope gimbal frames and certain rectangular bulkhead structures used in fuselage construction. Load-point elasticity is found to be represented by an expression analogous to that describing a simple beam deflection, multiplied by a function of a nondimensional parameter characterizing the shape of the frame and the rigidity of its members. That function is determined in the article and its values are calculated and plotted for a wide range of the frame parameters. The procedure and the deviation of the expressions are explained in detail, and the resulting tables and graphs are reproduced. *Aero Digest*, August 1, 1945, pages 115, 116, 118, 152, 154, 6 illus.

Superchargers

Presentation of Centrifugal-Compressor Performance in Terms of Nondimensional Relationships. B. E. Del Mar. What is termed a novel form of performance presentation is introduced which overcomes the common difficulties encountered in handling performance information about centrifugal compressors or superchargers. Nondimensional coefficients that embody measured test quantities are derived and a performance presentation is made, using values of these coefficients on a single combined chart. From this chart the pressure, temperature, flow, speed, and power quantities, associated with a given blower, may be predicted over a broad range of inlet and discharge conditions. Particular facility is offered for orientation with respect to operation at peak efficiencies, for avoidance of surge limits, and for direct performance comparison among different compressors. *Transactions of the A.S.M.E.*, August, 1945, pages 483–490, 11

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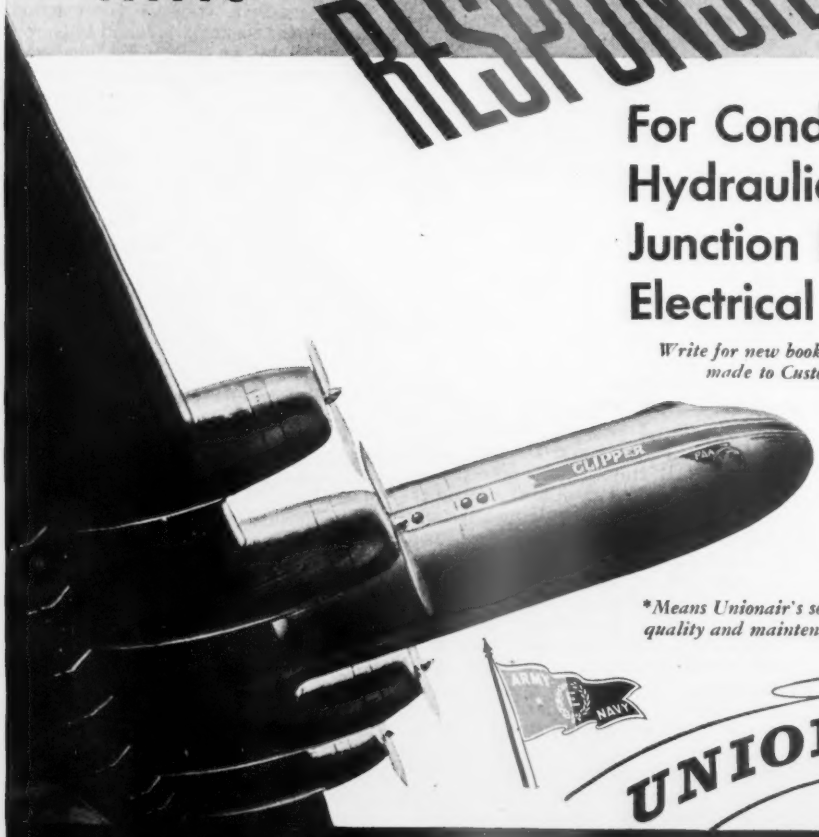

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illus.; "Centrifugal Compressor Performance in Terms of Non-Dimensional Relationships," by Bruce E. Del Mar, *Automotive and Aviation Industries*, August 1, 1945, pages 20–23, 78, 4 illus.

Coordination of Supercharger Speed to Manifold Pressure. John Dolza. A description is given of the type of control that is used with aircraft engines having two engine-driven superchargers, one of which is driven at constant ratio, and the other, called the auxiliary stage, driven at a variable degree of slip through a fluid coupling. It is explained that the engine-power control maintains the selected manifold pressure by automatically operating the carburetor throttle. The supercharger control is altitude-responsive, operating the scoop of the hydraulic coupling. It is stated that with this device it is possible to limit the manifold pressure below detonation independently from the pilot's selected pressure. The writer points out how it is possible to control the manifold pressure when it is 2 in. of mercury below borderline detonation on engines without an intercooler or aftercooler. *SAE Journal*, August, 1945, pages 491–496 (Transactions), 8 illus.

Testing

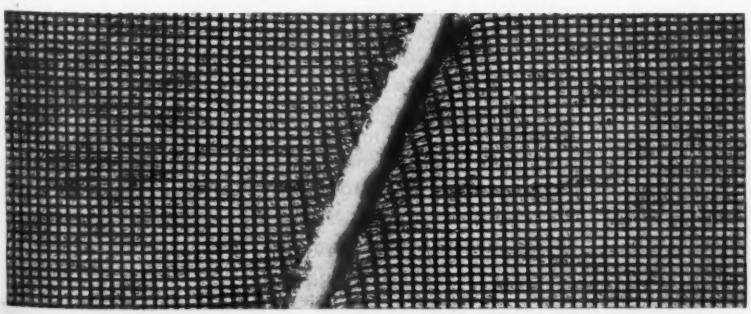
Ignition Testing Unit. A device for detecting faults in ignition systems without direct access to the running engine is reported. By means of this tester, the location of defects is translated pictorially as a row of peaked figures on the screen of a cathode-ray oscillograph. There is one figure for each spark plug, with the figures arranged in the firing order of the cylinders. Any fault in a plug causes a characteristic change in the corresponding figure, while imperfections in the magneto or the distributor alter the shape of the whole row of figures. Designed by D. Napier & Son, Ltd., and the English Electric Company, the unit also enables an estimate of the condition of the magneto, plug, and other ignition parts to be made. *Flight*, July 12, 1945, pages 47, 48; "Ignition Tester," *Aircraft Production*, August, 1945, page 363, 2 illus.

X-Raying of Magnesium Test Bars. Robert Taylor. This article discusses the value and procedures for inspecting magnesium test bars by X-ray prior to physical testing, in order to determine whether or not the bar itself is sound. Remarks about oxide inclusions in magnesium alloys supplement the notes about the X-ray examinations. *Aero Digest*, August 1, 1945, pages 101, 170, 1 illus.

Compression Testing of Magnesium Alloy Sheet. A. A. Moore and J. C. McDonald. Methods of compression testing as applied to magnesium-alloy sheet are described. Information is given about a rapid means of obtaining an autographic stress-strain curve, which, it is stated, should be useful for other metals. This method combines an adaptation of the Baldwin-Southwark Model PSH-8 extensometer with a Montgomery-Templin type jig. The results of tests made by various methods, including "pack" and single-sheet, are given for magnesium alloys in thicknesses from 0.016 in. to 0.250 in. The use of a reduced-section specimen is recommended. *ASTM Bulletin*, August, 1945, pages 27–30, 4 illus.

Block Testing of Aircraft Engines. Major Ezra A. Blount. The equipment and methods employed by the Air Technical Service Command for block testing of overhauled engines are detailed. Demonstrating the value of block testing for determining that an engine is in perfect running condition before it is installed in an airplane, the writer describes the four currently used types of engine-testing compartments, as well as the main types of test stands, test instruments, and control-room equipment. Data are given about testing routines to which the following engine parts are submitted: fuel system, lubrication system, cooling system, and air-induction system. Procedures involved in calibrating, trimming, and balancing propellers are outlined.

The article also contains information about the established processes for the upkeep of equipment used in block testing and for periodic checking of fuel and oil systems. Block-testing equipment surveyed with regard to maintenance includes the engine compartment, engine mount, operator's control room, instruments, and control system. *Aero Digest*, August 15, 1945, pages 81–83, 125, 126, 10 illus.



Photograph Courtesy Consolidated Vultee Aircraft Corporation

A tensile coupon of a 100-line-to-the-inch photogrid specimen showing grid distortion at the point of fracture.

Training

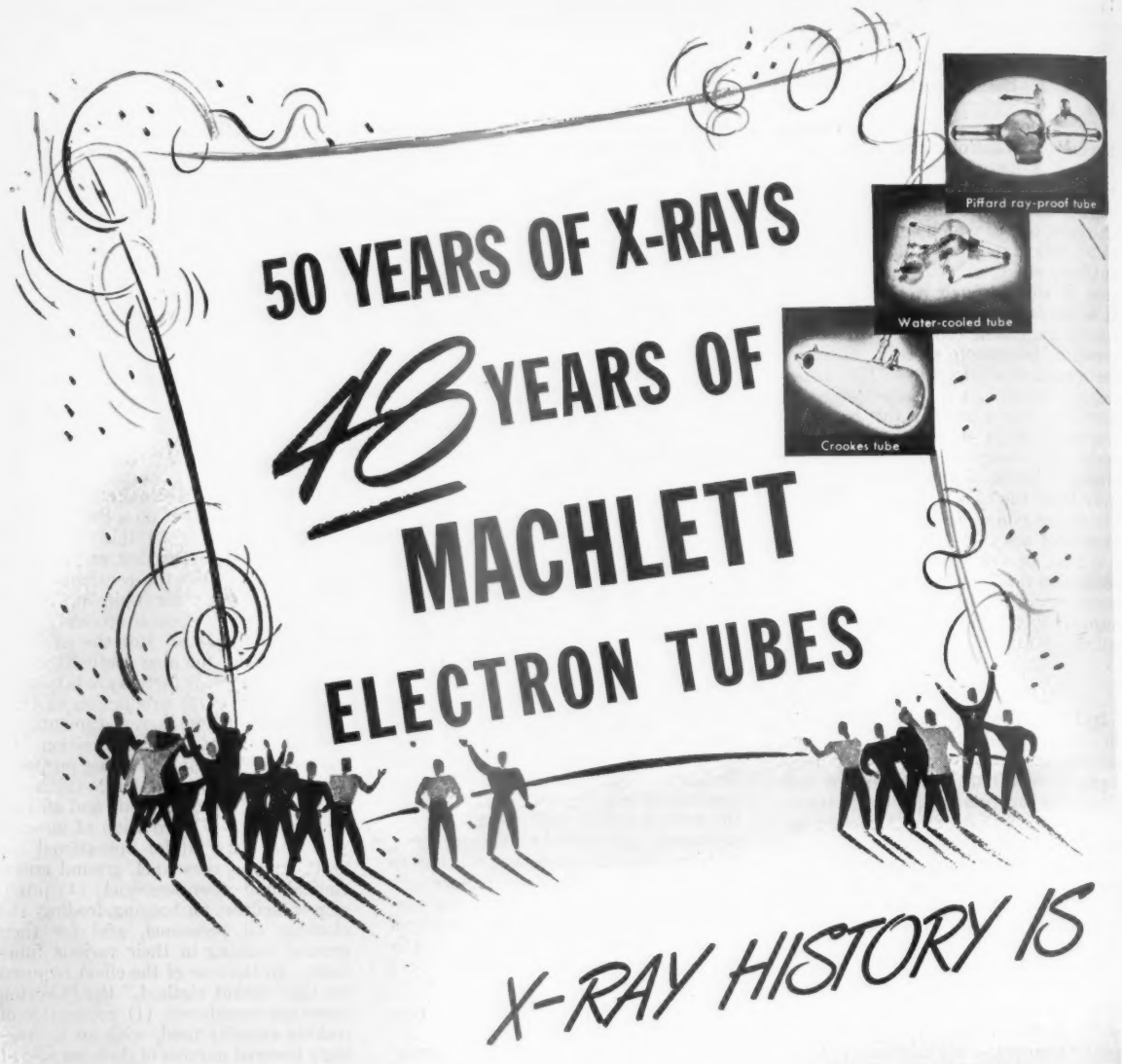
Synthetic Training. Particulars are given about a scheme for the collective training of entire air crews by methods similar to those used for pilot training in the Link Trainer. The method is to have a pilot, navigator, and radio operator, who have already received individual specialized training in their respective duties, brought together in a synthetic trainer that takes the form of a cubicle or, in some cases, the fuselage of a bomber. Then by means of external apparatus controlled by an instructor, they "fly" a course similar to that which they would meet in battle conditions. Drawings of the equipment illustrate the details given in the article. *Flight*, August 2, 1945, page 126.

Warfare

Bombers or Rockets? A. V. Cleaver. Evaluated on a basis of economy of technical effort, this is a comparative analysis of piloted and pilotless missiles. It offers the conclusion that, contrary to popular opinion, rockets may represent a greater economy of effort than bombers. For the effort required in the "bomber method" of attack, the following factors are taken into consideration: (1) production of basic bomber aircraft force, replacements and spares, bombs and ammunition, for both operational and training purposes, training aircraft, and fuel; (2) building and upkeep of airfields and all base installations; (3) provision of air-crew personnel required for operational aircraft, training personnel, ground crews, clerical, and other personnel; (4) provision of facilities for housing, feeding, and clothing all personnel, and for their ground training in their various functions. In the case of the effort required for the "rocket method," the following items are considered: (1) production of rockets actually fired, with an increasingly lowered number of duds because of further technical development; (2) production of fuel, used mainly for actual operations only; (3) building and upkeep of much simpler and cheaper installations; (4) provision and facilities for a much smaller force of personnel than that required for the bomber method. Other advantages over the bomber credited to the rocket are independence of weather, morale-breaking value, and the difficulties of defense against it. *Flight*, July 19, 1945, pages 67, 68.

The Future of the Rocket in Naval Warfare. Paul W. Martin. The progress that has been made in the development of rocket weapons during the past few years is reviewed. It is noted that in 1942 the Germans developed an extremely potent rocket device that was adopted and improved by the United States for use as an aircraft rocket gun. About this time carrier-based aircraft were equipped with these weapons, which were used with great effect on Japanese shipping.

The advantages and disadvantages of rocket weapons are examined. It is



IT WAS 50 YEARS AGO, on November 8, 1895, that scientific investigation led Roentgen to the discovery of X-rays. In this semi-centennial year we honor his work, and the work of the pioneers who, sometimes at the sacrifice of their own lives, developed the theory and practice of a science that today means so much to all mankind.

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explained that the chief advantages of the rocket projectile are the simplicity of its launching device and its great penetrating power. A disadvantage is lack of combat accuracy, but this, it is believed, will be overcome in time. How rocket weapon developments may lead to the development of successful small-displacement battleships is discussed. *United States Naval Institute Proceedings*, August, 1945, pages 904–907, 1 illus.

Weight Control

Weight Control in Racing Planes. Rodney Nimmo. Weight considerations for airplanes designed for racing are outlined. The writer reports his experiences in designing racing planes to meet the ideas of the pilots with regard to the strength and speed of the craft while keeping within the limits of the designed weight, as well as other experiences in the use of wood structures and fabric-covered components. How weight-control methods are applied during the building of a racing airplane is explained. Particular reference is made to establishing the center of gravity of the aircraft. *Weight Engineering*, Summer, 1945, pages 7, 8, 1 illus.

Welding

Resistance Welding. Part I. R. W. Ayers. This article is the first of two surveying modern developments and practical applications of resistance welding to aircraft construction. Part I explains the nature of resistance welding, indicates the differences between gas and arc welding on one hand and resistance welding on the other, lists materials that can be successfully welded, and classifies the four general types of resistance welding. These categories are (1) spot welding, including stitch welding; (2) projection welding; (3) seam welding; and (4) butt and flash welding.

With spot welding the main concern of Part I, the article then goes on to outline the principles of each phase of resistance welding and to review the progress of machine development in this field. Among the specific machines and equipment it describes are timers and contactors, electrodes, power-operated spot-welding machines, multiple-electrode machines, and portable spot welders. *Aircraft Production*, August, 1945, pages 379–384, 18 illus.

An Investigation of the Spot Welding of Aluminum Alloys Using Condenser-Discharge Equipment. W. F. Hess, R. A. Wyant, and B. L. Averbach. The purpose of this report is to describe the experience and results obtained with condenser-discharge welding equipment designed for the spot welding of aluminum alloys for aircraft structures. The equipment tested was provided by the Taylor-Winfield Corporation. Two models of this type of welder were investigated. The welding was limited to Alclad 24S-T in thicknesses of 0.020, 0.040, and 0.64 in. To familiarize the research staff with the operation of the equipment, a welding program of exploratory nature was first undertaken, using electrode tips of several sizes and shapes, at different machine settings. A description is given of the equipment used and the procedure followed, with reference to the exploratory work done in the beginning, the surface treatments applied, and the methods adopted after the initial experimental work. Studies of electrode impressions, weld characteristics, tip life, electrode pressure, and a rapid technique are given in detail. The results are summarized and conclusions are set forth. The writers have appended a note to the report calling attention to the fact that the work was performed in 1941 and adding comments to bring the report up to date with respect to developments since that year. *The Welding Journal*, August, 1945, pages 404-s–412-s, 13 illus.

Avoiding "Smut" from Aluminum Etchants. Fred Tauber. It is stated that fluoride preparations are frequently used as etchants for aluminum sheets prior to spot welding, but in many cases after removing the oxide they leave a black film on the surface of the etched metal, commonly called "smut." Cleaning off this smudge is an extra operation that adds to the time and cost of processing. The writer describes how this smut may be "decoyed" from depositing on the product by taking advantage of a well-known principle of electrochemistry involving the electromotive series of metals. *The Iron Age*, August 2, 1945, page 57.

Welding Technique in Construction of Fairchild "Packet." James A. Wales, Jr. A short description is given of the welding procedures used in the manufacture of the landing gear of the Fairchild C-82 Packet Army cargo plane. Techniques employed in welding components of the nose landing gear, main landing gear, and retraction-operating mechanism are outlined. *Steel Processing*, August, 1945, pages 496–498, 7 illus.

Progress in Heliarc Welding. T. E. Piper. Developments in the Heliarc method of welding magnesium and aluminum alloys and stainless steel are discussed. Particular attention is given to the use of a high-frequency current superimposed on the welding current.

Photograph Courtesy Fairchild Engine & Airplane Corporation

Welding the engine-mount assembly for the C-82 Packet. Each plane has two of these mounts, which support the Pratt & Whitney 2,100-hp. engines.

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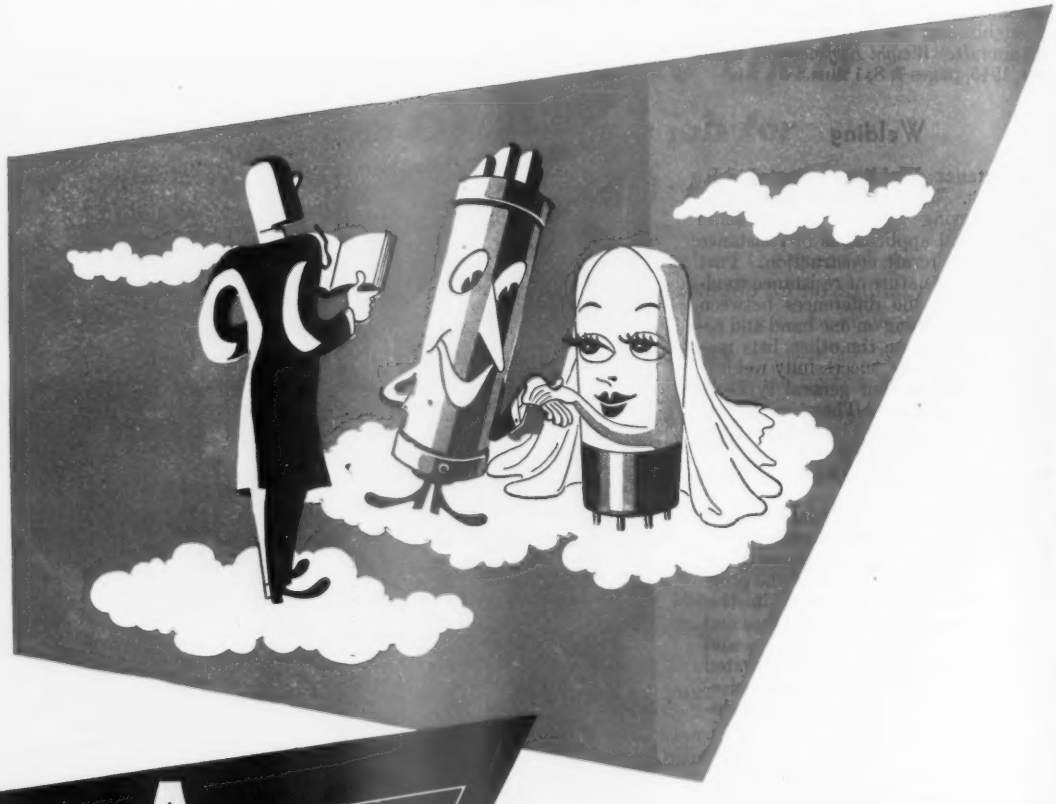

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The principle is embodied in a high-frequency unit manufactured by the Mid-States Equipment Company. It is stated that the use of high-frequency current eliminates the necessity for striking the arc and provides a more stable arc which results in high-quality, smooth-appearing welds. It is also stated that argon has been found to be as satisfactory a blanketing gas as helium. The physical properties of Heliarc and gas welds are compared. *Automotive and Aviation Industries*, August 15, 1945, pages 26–28, 78, 8 illus.

Flash Welding Alloy-Steel Rings. P. B. Scharf. The writer tells how alloy-steel rings are being produced by flash-welding methods similar to those that have been used extensively for mild-steel rings. The rings are used in the fabrication of many military devices, including certain parts for aircraft. The processes are described and the properties of various materials are tabulated. *The Iron Age*, August 16, 1945, pages 50–53, 7 illus.

Strength of Brazed Joints as Affected by Fit and Finish. W. H. Jones and B. W. Buist. It is shown that the quality and strength of furnace-brazed joints are affected by the fit, finish, and "cleanness" of the joint surfaces. The results are reported of an investigation of these variables for copper brazing, which was carried out by the Lockheed Aircraft Corporation. A chart shows the effect of differences in fit on the ultimate tensile strength of furnace-brazed joints. How the flow of copper in the joints affects the strength of the brazed joint is also described. *Product Engineering*, August, 1945, pages 530, 531, 5 illus.

Determining Surface Resistance of Aluminum for Welding. A description is given of a Kelvin double-bridge device that has been developed to help the welding engineer to improve his control over the cleaning and deoxidation of the aluminum stock. The apparatus consists of two basic parts, a press and the bridge. Its operation is explained. *The Iron Age*, August 16, 1945, pages 74, 146, 2 illus.

Wind Tunnels

Wind-Tunnel Wall Interference. G. H. Tidbury. The present state of the theory of wind-tunnel wall interference is summarized. Reference is made to the type of wind-tunnel work that frequently is carried out without a complete knowledge of the corrections. Corrections to the airflow in closed rectangular wind tunnels are discussed.

The first part of the article is concerned with the effect of the walls on the airflow at the lifting line. This involves the normal corrections to lift and drag, also corrections to yawing and rolling moments when the model is either yawed or has an asymmetric lift distribution caused by the deflection of ailerons or spoilers. Consideration then is given to the flow direction at any other point in the wind tunnel. This is usually important at cross sections of the tunnel behind the wing, in which a tailplane is normally found. The whole theory is based on the assumption that the tunnel walls may be replaced by a surface that reflects all vortexes, so that between two parallel walls there will be an infinite series of images of any one vortex line, and for a vortex placed in a rectangular tunnel there will be a double infinite series of images. *Aircraft Engineering*, July, 1945, pages 192–194, 4 illus.

Instrumentation of the Curtiss-Wright Wind-Tunnel. Nelson W. Burtt. Specific information is given about the instruments used for the operational control of the recently completed wind tunnel of the Curtiss-Wright Corporation at Buffalo, and the instrument engineering involved. The article is not concerned with the instruments employed in the actual testing of aircraft models. The writer describes the Foxboro recording pressure controller that provides automatic control of static pressure within the tunnel and the test chamber. He outlines the functions of the controlling device, telling how a single installation is made to do the work of two by means of a three-way pneumatically operated valve that permits control of both pressure and vacuum conditions in the tunnel. *Instruments*, August, 1945, pages 537, 566, 1 illus.

Wind Tunnel Results Processed by Machines. A general description is given of how machines are being used at the Southern California Cooperative Wind Tunnel to measure and record test data automatically. It is stated that the application of these machines to wind-tunnel force measuring and recording is new. Development work included the construction of a model for preliminary test purposes. Schematic diagrams are shown of the measuring, recording, and computing machines. *Weight Engineering*, Summer, 1945, pages 31–33, 3 illus.

Miscellaneous

Constructive Analysis of Accidents. Sgt. Libert Ehrman. A consideration of the constructive purposes that are served by analysis of aircraft accidents. Briefly explaining how the historical records of accident occurrences are assembled, correlated, and applied to current aviation problems, the writer indicates the value of such data to specific improvements in aeronautical engineering, personnel training, maintenance, traffic control, weather forecasting, etc. Methods of determining relative safety are discussed. In his investigation and analysis of aircraft accidents the writer refers to both military and civilian procedures. *Aero Digest*, August 15, 1945, pages 42–44, 142, 2 illus.

Changes of Address

To facilitate the prompt receipt of copies of the *Journal* and *Review*, members and subscribers are requested to give the editorial offices 30 days' notice of any change of address.

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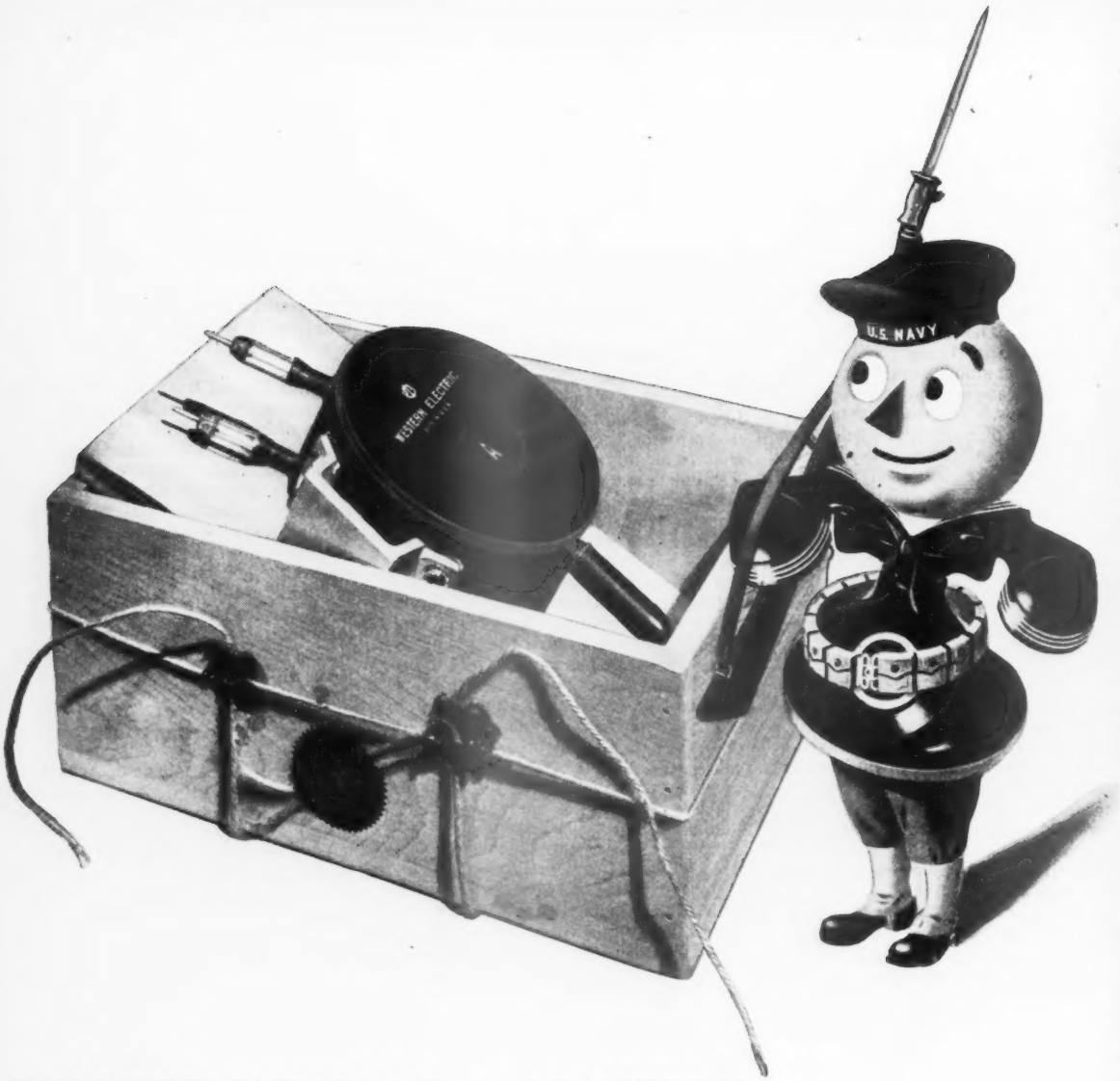

VICTORY REVEALS A MYSTERY

More than two years ago, an engineer of the Laboratories visited *U.S.S. Boise*, returned with a mysterious box which went into the Laboratories' vault. Now, victory opens the box and discloses a special kind of electron tube called a magnetron. It was part of a Radar which furnished data to aim *U.S.S. Boise's* guns during the night action off Savo Island on October 11-12, 1942. Because of the high frequency generated by this magnetron, the Radar was not detected by the enemy and the action was a complete surprise. Six Japanese warships were sent to the bottom of the sea.

This magnetron is a symbol of the Laboratories' enormous war program. Half of it was devoted to Radar, the other half gave birth to radio transmitters and receivers, sonar apparatus for the Navy, loudspeaker systems for ships and beach-heads, fire-control apparatus for anti-aircraft artillery. Coming months will unfold the story of these and many other contributions of the Laboratories to the victory of our arms.

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Government Publications

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Industrial Hygiene Manual. The information in this manual was compiled from recently published articles and books concerning industrial-hygiene subjects. It is intended that the information be used as far as possible under the existing facilities available at the respective depots. The manual is divided into groups referring to various chemicals, their composition and properties, uses, and poisonous effects. At the end of each group there is a list of references that can be used for more detailed study of the subject. *ATSC No. 25-2, Office of the Surgeon, Air Technical Service Command.*

Ask Them Another. Charlotte Knight. The work of civilian combat operations analysts in the Army Air Forces is described. As reported, these men are selected representatives from a wide variety of specialized fields (science, mathematics, law, economics, education, and many others) who, by practical studies, help to solve problems of tactics and strategy for the Air Forces. Assigned to an Air Force only upon request of the Commanding General, they are credited with having solved problems connected with flak defense, bombing methods, assessment of target damage, accidents, radar and communications, etc. The article contains data about who these analysts are, how they operate, typical studies made by them, the effectiveness of their work in improving A.A.F. methods and saving lives, and the advantages of their civilian status. *Air Force*, August, 1945.

Radar Altimeter Indicates True Height Above Terrain. Adoption by the A.A.F. of a radar altimeter, designed to indicate true height above terrain rather than altitude above sea level, has been announced by Headquarters, Air Technical Service Command.

This altimeter, developed by A.T.S.C.'s Aircraft Radio Laboratories, in cooperation with the Radio Corporation of America, has been in quantity production for nearly 2 years and is installed in all bombardment aircraft, as well as many other types of planes used for special missions.

Operating on the principle of radar pulse transmission, this altimeter transmits a radio wave downward. This wave is reflected and picked up on a small air-borne receiver, located in the same unit as the transmitter, which translates the time lag between the transmission and the subsequent reception into an indication of feet above the terrain.

This radar altimeter has not replaced the barometric altimeter in aircraft installations, but it is a valuable navigational aid, particularly when the pilot must know how high he is above a given target, when flying over mountains or in making a blind landing. *Air Technical Service Command.*

Strategic Air Victory in Europe. A special reprint of the July issue of the publication *Impact* contains several articles giving facts about the strategic bombing of Germany and German-occupied countries, as well as the numerous supporting operations. The text matter describes the campaign, telling how England was used as an island air base and how the objectives were successively achieved through the destruction of the German aircraft-manufacturing plants first, transport next, and, finally, the enemy's oil installations. Many photographs depict the extent of the destruction. *Office of the Assistant Chief of Air Staff, Intelligence.*

New Continuous Flow Fuel System. The danger of fuel systems as a potential cause of airplane accidents is claimed to have been practically eliminated as a result of a new continuous-flow fuel system developed by Army Air Forces engineers. This system enables a maximum supply of fuel to be maintained in the principal tanks at all times and automatically feeds gasoline to the engine as long as there is any left in the plane.

Previous to the development of this new system, the pilot had to switch the fuel-tank selector valve to the main tanks at the take-off, then flip it over to an auxiliary internal or droppable wing tank during flight. When this supply of fuel was used up, he had to switch back to the main tank. The new system was developed to provide a continuous flow of fuel without interruption or change in pressure and is based upon a simple arrangement of fuel lines and the use of a simple float-operated valve.

It is credited with many important advantages over all previous fuel systems. It does not require operation by the pilot, thereby tending to avoid accidents caused by improper selection of fuel tanks. It increases the combat efficiency of the plane, assures the use of the maximum amount of fuel on board the plane, reduces the potential failures of the fuel system, and eliminates selector-valve leakage. *Air Technical Service Command.*

HO 218 Plus. . . . Lt. Glenn J. Twist. A procedure is proposed by which the Morse method of plotting longitude in celestial navigation can be adapted to the standard HO 218 tables. General instructions are given, and a typical problem is worked out based on the use of the sun. Assuming a position near 7° North latitude, time 0233 Greenwich Civil Time, date April 10, 1945, and sextant altitude 29° 57′, the plotting longitude is found to be 157° 16′ West. However, this differs from the correct longitude by $^1/_2$ min., so directions are given for correcting that error. It is stated that this procedure has a definite place as a supplement to present methods. *LOG of Navigation*, August, 1945.

Civil Aeronautics Administration

Airport Facilities. . .Record System Manual. Directions are given for the preparation and maintenance of forms ACA-29A and Q-29 in connection with airport-facilities records. The manual is divided into four parts: the first contains instructions and definitions; the second outlines the recommended requirements for standard sketches; the third presents recommended regional procedures for control and assignments; and the fourth deals with forms, procedure, and statistical services. *Airport Service Division.*

Surplus Airplane Market. A 20-page pamphlet contains an analysis of the sale of surplus airplanes by the Civil Aeronautics Administration War Training Service. In addition to comments regarding the prospects for sales of these civilian aircraft, there are tables and charts giving statistics with reference to the numbers and types sold, prices realized, location of purchasers, and other factors. *Aviation Information Division.*

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Aircraft Electrical Circuit Breakers. The C.A.A.'s present policy concerning circuit breakers permits the use of trip-free breakers only, except that nontrip-free (manually overriding type) breakers may be used in emergency circuits, such as those to propeller-feathering motors and emergency fuel-pump motors, provided flameproof cable is used in the circuits. The elimination of any protective device in those emergency circuits has also been permitted, provided flameproof cable has been used. Fuses are not permitted in such circuits on new aircraft models.

The purpose of this release is to request the opinion of industry, operators, and pilots regarding the use of circuit breakers as protective devices in aircraft electrical systems. The C.A.A. is interested in obtaining comments of any nature on the subject and is particularly interested in obtaining opinion concerning the use of trip-free versus nontrip-free breakers. Information regarding actual experience with these two general types of breakers, whether in connection with military or civil aircraft, will be of particular benefit.

The release outlines three points of view with respect to the design and use of such equipment and expresses opinions of the advocates of the different procedures. A list of questions is appended, the answers to which are requested by the Aircraft Engineering Division. *Safety Regulation Release No. 187*, July, 1945.

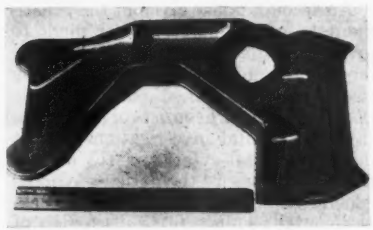
Conversion of Piper TG-8 (Army TG-8), Taylorcraft ST-100 (Army TG-6), and Aeronca G-3 (Army TG-5) Gliders to Powered Aircraft. In order to assist those who contemplate purchasing and using gliders, the C.A.A., in cooperation with the glider manufacturers, has established procedures for handling the certification of these gliders converted to powered aircraft.

Detailed instructions are given for conversion of each of the specified types and for the use of glider parts in certificated aircraft. A list of parts is appended. *Safety Regulation Release No. 188*, July, 1945.

Civil Aeronautics Board

Amendment No. 8 to CAB Form 2780 Manual. Revised pages for the Uniform System of Accounts for Domestic Air Carriers constitute Amendment No. 8 thereto. The system of numbering amendments to the Manual has been changed to conform to the amendment numbers shown in the orders of the Civil Aeronautics Board, rather than numbering from the introduction of the printed Manual.

Amendments numbers 1 to 7, inclusive, shown on page II, can be disregarded, since all presently effective revisions applicable to the Manual are included in Amendment No. 8. *Audits Section, Economic Bureau.* For sale by the Superintendent of Documents, Washington, D.C., $0.15.



An aircraft part forged from Reynolds Metals Company's new R303 aluminum alloy. R303 is claimed to provide a tensile strength as high as 85,000 lbs. per sq.in., while the usual specified tensile strength for aluminum commonly used in forging aircraft parts is 65,000 lbs. per sq.in.

The part illustrated was forged on a 12,000-lb. hammer from 3¼-in. round stock and is stated to be the largest forging yet to be made from an aluminum alloy of such high strength.

Scheduled Common Carrier Airlines of the World in Operation 1945. Including companies of all countries, this is a directory of commercial air lines now operating scheduled common-carrier services. The directory is divided into three parts: In Table 1 each air line is listed alphabetically, and the popular name, address, and cable address is given for each, together with its region of operations and number of route miles. In Table 2, the air line is listed alphabetically by its popular name, while its full name is also given. Table 3 groups the air lines by regions, alphabetizing them according to popular name under each regional heading. *Air Transportation Information Division.*

Department of Labor

Effect of War-Contract Cut-Backs on Selected Plants. The results of a survey of 80 establishments in 25 localities are reported with regard to the effect of cutbacks in war contracts upon the plants, employees, and communities involved. The survey related to the first period of major achievements in war production during the latter part of 1943 and early 1944. The report describes the extent of the adjustment of the labor forces and steps taken by management and other interested parties to offset any adverse effects. *Bureau of Labor Statistics, Bulletin No. 818*, March, 1945. For sale by the Superintendent of Documents, Washington, D.C., $0.05.

Women in Factories, 1939–1944. A study of trends and percentages of the number of women employed in United States factories during the years 1939 to 1944. In the analysis differentiation is made between employment in durable-goods groups and nondurable-goods groups of industries. The tables and charts that comprise the major portion of the pamphlet show the estimated number of women wage earners in manufacturing industries; per cent of women wage earners in manufacturing industries; wage earners in manufacturing industries, by sex; estimated employment of women wage earners in all manufacturing, durable goods and nondurable goods; employment of women by major manufacturing industry groups; and number of women per 100 wage earners in manufacturing industries. *Bureau of Labor Statistics*, March, 1945.

Department of State

Blueprint for World Civil Aviation. Originally printed in the form of magazine articles, this group of treatises analyzes the accomplishments and implications of the Chicago International Civil Aviation Conference of 1944. All four of the writers were members of the United States Delegation to the Conference. The first article, "Freedoms of the Air," is by Adolf A. Berle, Jr. The second, "The International Civil Aviation Conference at Chicago: What It Means to the Americas," is by Stokeley W. Morgan. "Opening the Sky: American proposals at Chicago" is the work of William A. M. Burden; and Edward P. Warner is the author of "The Chicago Air Conference: Accomplishments and Unfinished Business." *Department of State, Publication 2348, Conference Series 70.* For sale by the Superintendent of Documents, Washington, D.C., $0.15.

National Advisory Committee for Aeronautics

Supersonic Wind Tunnel for Jet Propulsion Research. Fundamental research on aircraft propulsion plants operating at equivalent sea-level velocities up to and beyond 2,000 m.p.h. is now being conducted in a new type of supersonic wind tunnel recently completed at the National Advisory Committee for Aeronautics aircraft-propulsion research laboratory in Cleveland.

The new N.A.C.A. wind tunnel is a unique research facility for investigating at supersonic velocity the operating characteristics of models of turbojet, ram jet, and similar engines expected to propel aircraft and guided missiles through space at speed hitherto unrealized except by projectiles shot from guns.

This supersonic wind tunnel, together with the Altitude Wind Tunnel, extends the propulsion research capabilities of N.A.C.A.'s Cleveland Laboratory to extremes of both altitude and speed. The extensive air-drying and low-temperature apparatus is utilized to provide the required dry air for the supersonic tunnel, and its exhauster installation is utilized to draw air through the supersonic wind tunnel at high velocity.

The tunnel has a cross section of 2¼ sq.ft. In the tunnel the model propulsion device is mounted in such a way as to measure the aerodynamic forces on it, as well as the thrust developed. Complete instrumentation is provided to determine performance characteristics with various fuels at different speeds and other operating conditions.

Schlieren camera apparatus is used to record airflow and compressibility effects on the model. This apparatus acts to magnify, delineate, and photograph the pressure lines of airflow so that means of securing both the proper aerodynamic shape, as well as the directing of combustion and cooling air into the propulsion plant, can be studied.

Some Investigations of the General Instability of Stiffened Metal Cylinders—Part V. Stiffened Metal Cylinders Subjected to Pure Bending. The fifth of a series of reports relating to an investigation of the general instability problem by the California Institute of Technology summarizes the work that has been carried on in the experimental investigation of the problem of general instability of stiffened metal cylinders subjected to pure bending. This part of the investigation included tests of 46 sheet-covered specimens.

The investigation was planned so as to include most of the essential variables involved in the problem and was sufficient in scope to determine a suitable design parameter. Although this parameter was obtained for specimens subjected to pure bending, it is felt that it may be possible through suitable modifications to use the same parameter for combined loadings. The experimental data are also sufficient to allow a thorough check on theoretic methods for predicting general instability. A comparison of the predicted and experimental results is included in this report.

An account is also given of the experimental studies that have been made to give a better understanding of the mechanism involved in the buckling phenomena of stiffened cylinders. The body of this report consists of four parts: (a) experimental investigations on the failure of metal cylinders; (b) a comparison between theoretic predicted general instability stresses and the experimental results; (c) a discussion of the mechanism involved in the buckling phenomena of stiffened cylinders; and (d) a new design parameter.

Part VI. Stiffened Metal Cylinders Subjected to Combined Bending and Transverse Shear. The experimental results reported in the sixth part indicate that, for combined bending and transverse shear, the failure is characterized by two distinct types—namely, a bending or a shear failure. If the failure is bending, the failing strain can be predicted with sufficient accuracy by means of the pure bending parameter. However, it is still necessary to determine a shear failure parameter in order to ascertain when a bending or a shear failure will occur. Because of the limitation imposed by the specimen length on the maximum shear that could be applied, it was difficult to obtain shear failures. In the combined bending and torsion experiments additional data on shear failures will be obtained which may be sufficient to lead to a suitable shear parameter.

Part VII. Stiffened Metal Cylinders Subjected to Combined Bending and Torsion. The seventh report contains a summary of the experimental investigation of the general instability of stiffened metal cylinders subjected to combined bending and torsion. A total of 26 sheet-covered specimens were tested to determine the effects of combined loading and bending plus torsion, and an additional 17 specimens have been tested to determine the effects of a pure torsion load. The results of tests in combined bending and torsion are discussed and the test data of the pure torsion tests are included. *Technical Note No. 909*, August, 1943; *T.N. No. 910*, September, 1943; *T.N. No. 911*, November, 1943.

Part-Throttle Operation and Control of a Piston-Ported Two-Stroke Cylinder. A. R. Rogowski and C. Fayette Taylor. The single-cylinder piston-ported two-stroke engine described in *Technical Note No. 674* was used to investigate means of obtaining reliable operation under idling conditions. The fuel-consumption characteristics of the engine were also studied over the useful range of speeds and loads, using several different fuels. Fuel was supplied to the engine as vapor mixed with the inlet air and also by direct injection into the cylinder.

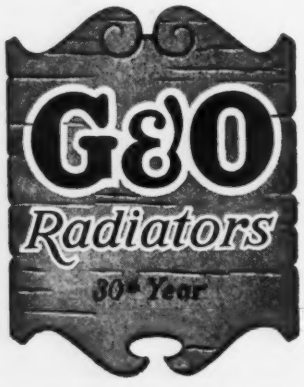
With fuel injection into the cylinder, it was found possible to idle satisfactorily; the only adjustments necessary were scavenging pressure and fuel rate. Fuel consumption with injected fuel was comparable with that of small four-stroke aircraft engines. A specific output of 2.73 net b.hp. per sq.in. of piston area was obtained at an engine speed of 1,800 r.p.m. and a scavenging ratio of 1.4. *Technical Note No. 919*, November, 1943.

Navy Department

Blueprint Reading and Layout Work. A 1945 edition of one of the Navy Training Courses series, this book is intended as a primer in blueprint reading and layout work for enlisted Navy personnel. A broad interpretation of modern blueprint usage is followed by fundamental instructions on how to look at orthographic projections. A study of the language of blueprint lines, symbols, conventions, and sections is also included. Information about layout tools, procedure and practice layout, and templates and directions for reading technical manuals are given. *Prepared by Standards Curriculum Division Training, Bureau of Naval Personnel.* For sale by the Superintendent of Documents, Washington, D.C., $0.40.

Office of Scientific Research and Development

Science, The Endless Frontier. Vannevar Bush. Submitted by the Director of the Office of Scientific Research and Development, this is a 184-page report to the President of the United States regarding a program for scientific research. It stresses the need for general scientific research.



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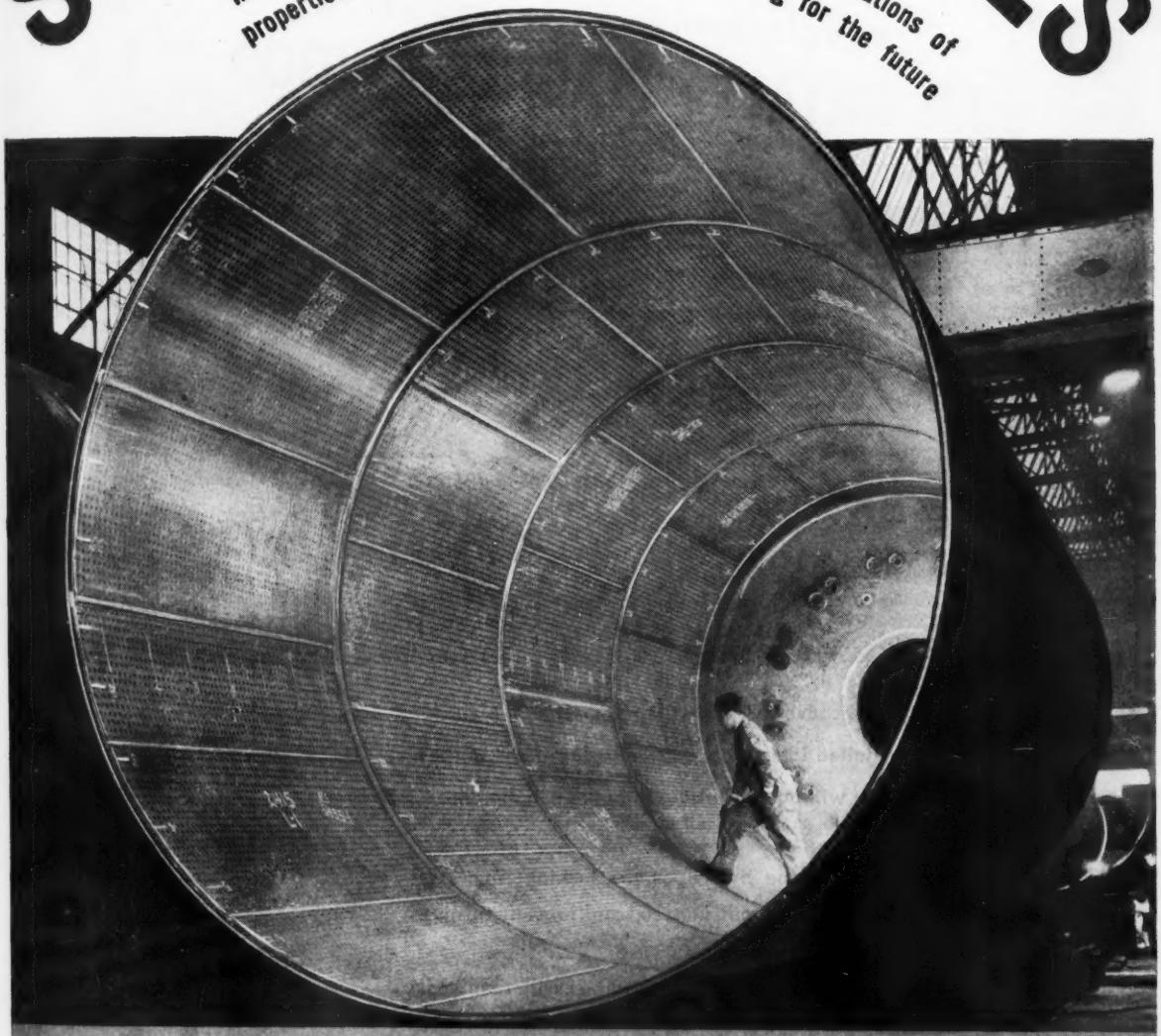

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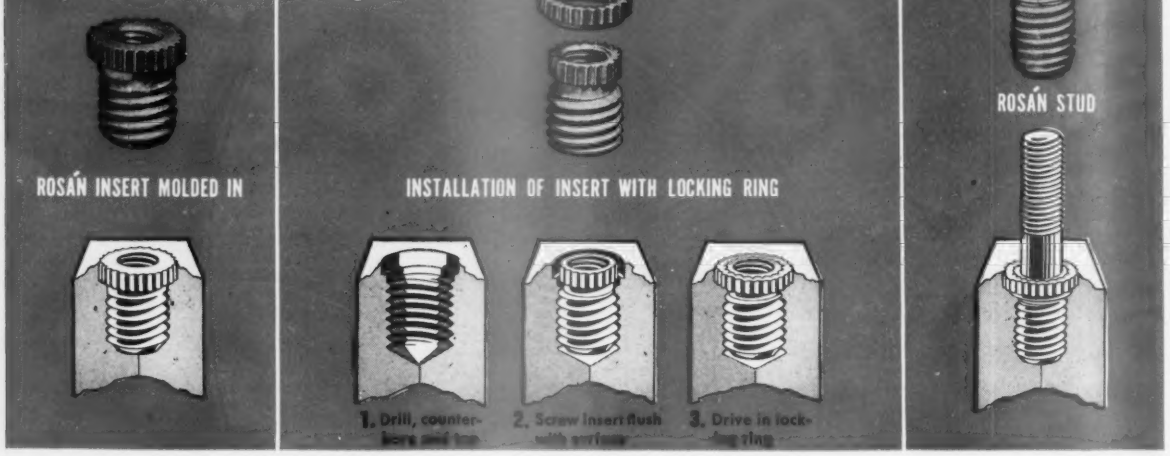

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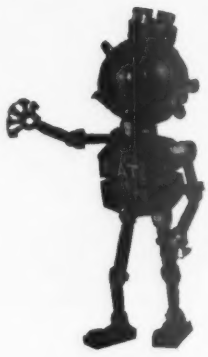

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After an introduction in which the relationship of government to scientific progress is considered, the report deals with the struggle against disease, the importance of scientific research to the national security and the public welfare, and means for maintaining and renewing the nation's scientific talent and suggests a program for action.

The chapters are as follows: The War Against Disease; Science and the Public Welfare; Renewal of Our Scientific Talent; A Problem of Scientific Reconversion; The Means to the End.

Appendixes contain the full texts of the reports of various committees that have studied the questions involved.

Radar: A Report on Science at War. In simple outline form the nature of radar, its applications, and the record of its use in the war are described. Beginning with an explanation of how radar works and a review of its early history, this pamphlet tells of wartime radar development in the United States, special problems connected with the use of radar for air defense on land and at sea, the employment of radar in antisubmarine warfare, the air campaign against shipping, offensive air strategy, tactical air warfare, naval warfare, and electronic navigation. One chapter deals with radar personnel and their training; another, with the uses of radar in the peacetime world. An appendix contains technical information about radar systems. *Joint Board on Scientific Information Policy.* For sale by the Superintendent of Documents, Washington, D.C., $0.15.

Office of War Information

U.S. Government War Information Films. A directory of the 16-mm. films that are available from the Office of War Information gives a brief description of each film's subject matter. It also notes the running time of each motion picture. The names of all the films are listed alphabetically at the beginning of the pamphlet under six classifications: Our Fighting Forces; Our Allies; The Nature of Our Enemies; The Production Front; The Farm Front; and the Home Front. Films about the Air Forces and the aeronautical industry are included in the list. *Bureau of Motion Pictures.*

U.S. Naval Air Stations

Contact. The August 1, 1945, issue of the News Letter of the Naval School of Aviation Medicine at Pensacola, Fla., contains articles of which the following are brief reviews:

"A Brief Description of an Army Experimental Test Project in the Aleutians," by Lt. (j.g.) Donald E. Stullken. An account of a project authorized to test certain experimental life-raft gear designed especially for survival on cold oceans. The apparatus and operations are described and the participating officers are named.

"Disorientation in Pilots," by Comdr. Ashton Graybiel. The causes and effects of the disturbance known as disorientation are analyzed and tabulated.

"A Tour of Duty in the Arctic," by Sr. Asst. Surgeon Timothy F. Lally. An account is given of the operations involved in the establishment of outposts in Greenland and Iceland by units of the U.S. Navy in the early part of the war. The medical aspects of the work are emphasized, and it is concluded that the Arctic regions are a relatively healthy climate from the standpoint of military medicine by comparison with other theaters of operation.

"Resume of Extended Night TBM Operations in Combat Theatre," by Lt. B. A. G. Weisl. A brief report is made of the activities of a composite squadron that was engaged in antisubmarine warfare in the Pacific.

"Some Problem Cases on a CV," by Comdr. John T. Smith. Excerpts are taken from a long report from the Bureau of Medicine and Surgery with regard to certain mental and physical illnesses and injuries experienced by naval personnel, including fighter pilots. *School of Aviation Medicine, U.S. Naval Air Station,* Pensacola, Fla., August 1, 1945.

Australian Council for Aeronautics

Ducted Fans: Approximate Method of Design for Small Slipstream Rotation. G. N. Patterson. A method of designing propeller-type fans with straighteners is described. This method is based on having a large and relatively constant lift/drag ratio along the blade and having a small straightener loss coefficient compared with the coefficient of pressure rise at which the fan operates. With the proposed system of design, no successive approximations or graphic methods are required, and the detailed design need only be done once after the basic design factors are fixed and the resulting overall torque, thrust, power, and efficiency have been found to be satisfactory. *Report ACA-8,* August, 1944.

Ducted Fans: Effect of the Straightener on Overall Efficiency. G. N. Patterson. The conditions set out in a previous report by the writer, designated as ACA-7, 1944, which led to the design of a fan-straightener unit of high efficiency, have been extended by examination of the part played by the straightener. The best operating condition of the straightener blade element has been determined and applied to the case of the National Physics Laboratory straightener. The problem of design for high efficiency is summarized in three final conditions that show the designer how to obtain the maximum efficiency possible with a fan-straightener unit. The results of the investigation show that high efficiency in a fan-straightener unit corresponds to an increase of pressure through the unit of about the same order as the initial dynamic head in the annulus in which the unit operates. This means that, in ducts where the total pressure rise is large compared with the dynamic head, a number of fan-straightener units (or stages) must be used if high efficiency is to be maintained. *Report ACA-9,* September, 1944.

Ducted Fans: High Efficiency with Contra-Rotation. G. N. Patterson. Fourth in a series on the subject of ducted fans, this report gives the theory of ducted contrarotating fans along with two methods of design. It demonstrates that high efficiencies are possible with a counterrotating system and that these high efficiencies can be attained at larger pressure rises than in the case of a fan-straightener combination. *Report ACA-10,* October, 1944.

The Torsion of Solid and Hollow Prisms in the Elastic and Plastic Range by Relaxation Methods. F. S. Shaw. The problem of the torsion prism has not been found tractable by exact mathematical methods for many of the members common in engineering practice. To overcome this, recourse has been had to two methods of solution: (a) experimental and (b) approximate numerical, usually depending upon the use of finite differences. Of the former the membrane analogy is probably the most useful. This paper gives examples of the use of the latter method as devised by Christopherson and Southwell and known as relaxation methods. By freely borrowing ideas from the membrane analogy, it has been found possible to use the relaxation methods for solving problems in the plastic, as well as in the elastic, range of the material. Problems involving multiconnected boundaries are also capable of solution. Problems treated in this paper include: (1) Simply-connected boundary—a commercial rolled steel joist section; (2) multiply-connected boundary—a splined shaft; (3) multiply-connected boundary, plastic behavior—hollow rectangular section.

The accuracy of the relaxation methods is discussed, and some comparisons are made with known solutions. In general, it seems that accuracies involving errors of the order of 1 per cent may reasonably be expected. It is shown that the method may be extended and used for nonisotropic materials—in particular, wood. A set of numerical tables for assistance in computation is included. *Report ACA-11,* November, 1944.

The Buckling of Flat Plywood Plates in Compression. R. C. T. Smith. Reference is made to studies of buckling of isotropic plates under edge thrust for various loading cases and boundary conditions, particularly the work of Timoshenko, Seydel, and H. W. March. Further exact solutions are considered desirable because of the large effect of the boundary condition on the buckling load. One such problem is solved in the current paper for three different sets of boundary conditions. A restricted type of anisotropy (orthotropy) is assumed in which the plate possesses two axes of elastic symmetry at right angles. Such anisotropy is possessed by normal plywood. A short discussion of the elastic behavior of wood and plywood is given in Part I

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and the equation appropriate to the buckling of plywood under edge thrust is derived.

The problem is that of finding the buckling load of an orthotropic rectangular plate under uniform compression in one direction only. The three cases considered are: In Part II, ends clamped, sides simply supported; in Part III, ends simply supported, sides clamped; in Part IV, all edges clamped. Exact solutions are obtained for the first two, but an approximate method (the Rayleigh-Ritz procedure) is used for the third.

The results bear a simple relation to those for isotropic plates and agree, apart from a small correction term, if the bending stiffness in the "isotropic" formula is replaced by the geometric mean of the stiffness in the two principal directions and if the ratio of sides is multiplied by a factor depending on the ratio of these stiffnesses. Flat plywood panels have been tested under the first set of edge conditions, and a brief comparison is given between these results and theoretic values. *Report ACA-12*, December, 1944.

British Information Services

Natural Frequencies of Vibration for a Wing Carrying Wing Engines. G. C. J. Dalton, F. S. Shaw, and R. V. Southwell. A problem concerning the masses and stiffness figures for a particular design of wing was investigated. The wing carried engines and was attached to a fuselage that was intended to be treated as rigid. The data (in effect) reduce the wing to a system of six degrees of freedom. The investigators have determined its six natural frequencies together with the associated modes under the following conditions: (1) when both wings vibrate in phase, so that the fuselage, which is free to move, pitches but does not roll; and (2) for antiphased vibrations that roll but do not pitch the fuselage. The methods employed were the natural extensions of the "relaxation" technique, which has been described in a recent paper to which reference is made. Knowledge of this paper is presumed, so that the description is restricted to features of importance in the present calculations.

An essential feature of the relaxation treatment is its presentation of computations in tables that are largely self-explanatory. Consequently, little description is needed except with regard to the formulation of expressions for the kinetic and potential energy based on the data furnished for this particular problem. *Ministry of Aircraft Production, Aeronautical Research Committee R. & M. No. 1918; British Information Services*, New York, $1.20.

Structures of Minimum Weight. H. L. Cox and H. E. Smith. An attempt is made to set up standards of optimum efficiency for certain simple structures on a basis of minimum weight. The dimensions of a structure are divided into two groups, the values of one group being specified *ab initio* and the values of the other being variable to meet the loading conditions specified. It is shown that the number of variables in the latter group is reducible to the number of possible modes of failure, and a logical procedure for fixing the values of these variables so as to make the total weight of structure the least possible is developed. It is shown that this minimum weight depends on the qualities of the materials of construction, on the "structure loading coefficient"—that is, the ratio of a typical load to the square of a typical dimension—and on the factors of safety provided against failure in the several possible modes. The nature of this dependence is established for examples of tie-bars, struts, wide struts, grid frameworks, and stiffened panels.

The conclusions are summarized in several formulas and diagrams. Whereas the specific weight (weight per unit length divided by the load) of a tension member is an increasing function of its structure loading coefficient, that of a compression member is a decreasing function of this parameter. *Ministry of Aircraft Production, Aeronautical Research Committee R. & M. No. 1923; British Information Services*, New York, $1.75.

Two-Dimensional Supersonic Aerofoil Theory. M. J. Lighthill. Previous work on the theory of sharp-nosed airfoils in a supersonic stream is connected and summarized. The report offers proof of the behavior of such a stream flowing past a smooth surface. Except insofar as the effects of viscosity are ignored, practical methods and tables are given for the exact calculation of the forces on such an airfoil. Results of these methods and tables are compared with certain convenient approximations. *Ministry of Aircraft Production, Aeronautical Research Committee, R. & M. No. 1929; British Information Services*, New York, $1.05.

Force and Pressure Measurements on V-Shapes on Impact with Water Compared with Theory and Seaplane Alighting Results. E. T. Jones and R. W. Blundell. Measurements of pressure and total impact force on a V-shape and on seaplane hulls have been made, and it was found desirable that further tests be made, comparing the complete results with the impact theory. The investigation is presented in three parts, the first of which extends the pressure measurements described in Marine Aircraft Experimental Establishment *Report No. F/Res/78* to include the effect of transitional velocity. Further measurements of impact forces are made. In the second part the experimental results from Part I are compared with full-scale work. In Part III the results of Wagner's theory of impact force are compared with the experimental results. Conclusions are summarized. *Ministry of Aircraft Production, Aeronautical Research Committee R. & M. No. 1932; British Information Services*, New York, $1.20.

On the Drag of Circular Cylinders at High Speeds. A. E. Knowler and F. W. Pruden. Measurements have been made of the drag of circular cylinders at speeds up to Mach Number 0.85 by means of the electrical balance in the circular high-speed tunnel and by pressure-plotting in the rectangular high-speed tunnel. The measurements were confined to cylinders that did not show the usual critical drop in the drag coefficient at a Reynolds Number near 0.25×10^6. The value of the drag coefficient started to rise at about Mach Number 0.35, after which it rose at an increasing rate to a maximum at about Mach Number 0.7; this was succeeded by a minimum at Mach Number 0.75 and a sharp rise at Mach Number 0.85. The speeds at which the maximums and minimums of the curves occurred for cylinders of various diameters were used to correct for tunnel interference in the circular tunnel. Photographs were taken of the shock-wave system in the rectangular tunnel at various speeds. *Ministry of Aircraft Production, Aeronautical Research Committee R. & M. No. 1933; British Information Services*, New York, $0.75.

Report on R.A.E. Annular Airflow Orifice. A. R. Howell. Various methods of measuring airflow in a pipe are investigated with a view toward establishing a standard and consistent procedure for all Air Ministry establishments and contractors. Difficulties experienced with the Royal Aircraft Establishment sink-type airflow meter are outlined, and a description is given of the R.A.E. annular airflow orifice. Comments are made about the effects of entry conditions, position of pressure-measuring holes, disc form, annulus width, and other factors. It is concluded that, for an orifice designed in accordance with the information given, the discharge coefficient up to pressure ratios of about 1:10 can be taken as 0.645, independent of entry conditions. For more accurate work the variation in the discharge coefficient attributable to the annulus width should be taken into account. *Ministry of Aircraft Production, Aeronautical Research Committee R. & M. No. 1934; British Information Services*, New York, $0.30.

Britain's Fighting Forces. A pamphlet, giving a brief description of the work of the British military, naval, and air forces, contains a section outlining the job of the Royal Air Force, as well as sections devoted to the British Army, the Royal Navy, the Commandos, and the services of the combined armed forces. *British Information Services*, New York.

Victory in Burma. A record of the Allied campaigns in Burma. This brief history not only tells of the battles that took place in order to drive the Japanese out of Burma but also describes the strategic importance of Burma, the nature of the country, the overall plans of the Allies in the Burmese area, the counterplans of the Japanese, and the Allied preparations for control of Burma. A report is given of the various services taking part in the operations. Among these, the role of the air forces is featured. *British Information Services*, New York.

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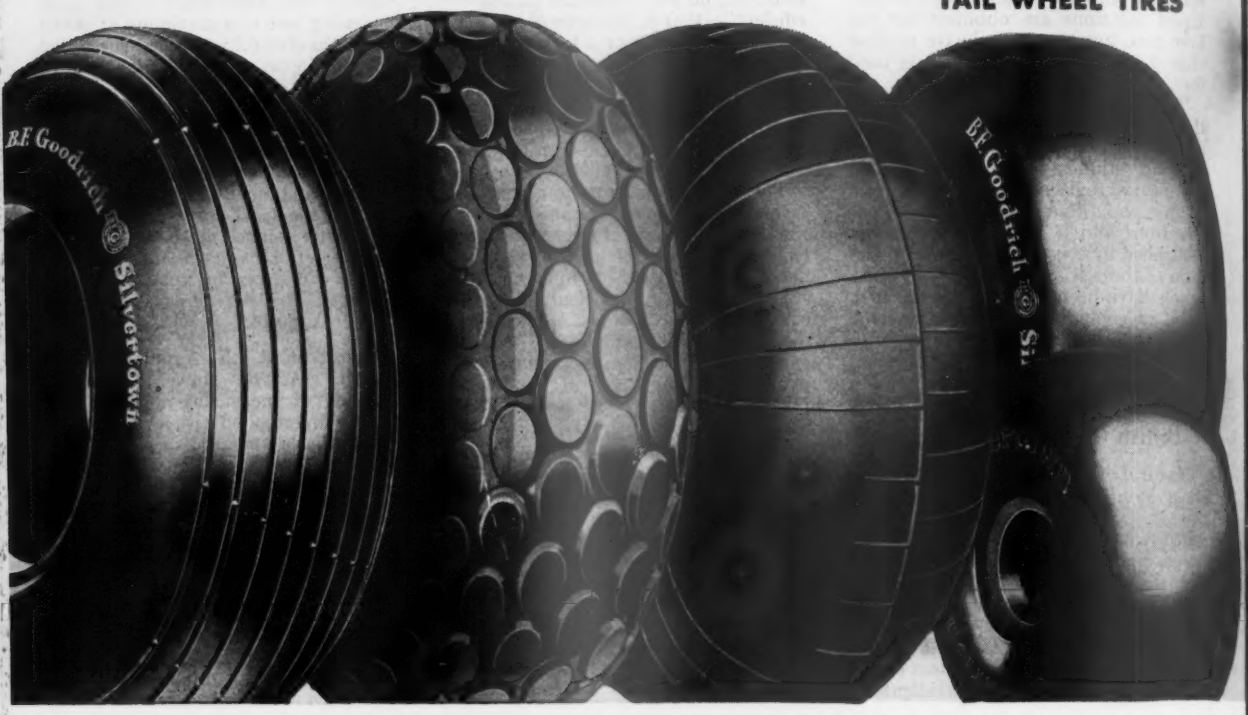

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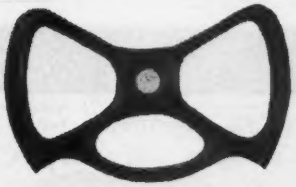

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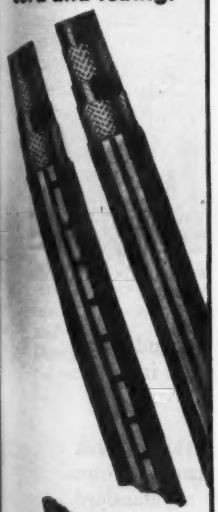

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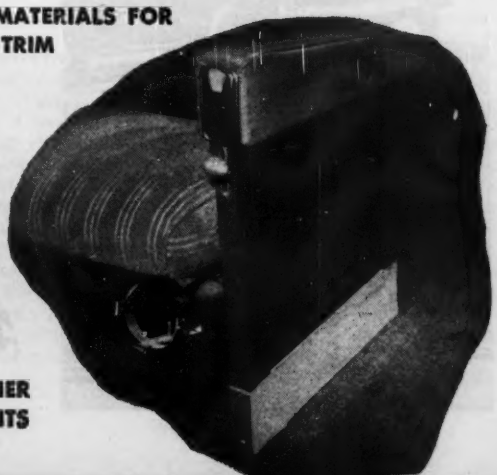

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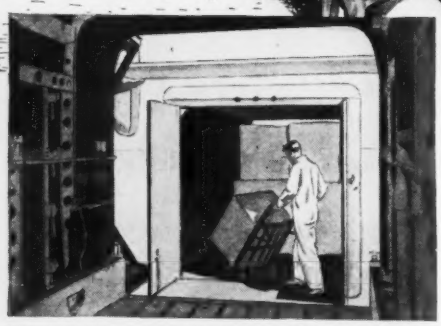

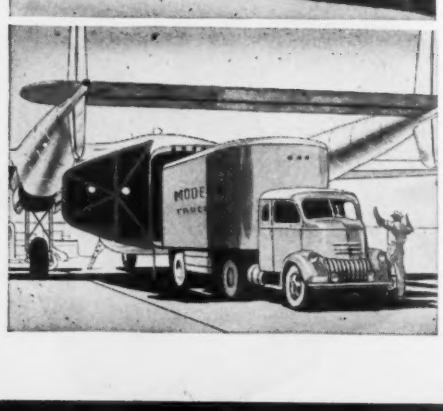

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Men Under Stress

Lt. Col. Roy R. Grinker and Major John P. Spiegel

Contents: The Men; The Environment of Combat; The Reactions to Combat—Morale; The Reactions after Combat; Civilian Applications.

The stress of war has exposed many new underlying physiologic and psychologic mechanisms of the human being. This has been particularly true in connection with flying personnel. In this medical book the authors give the results of their observations and experiences in treating neurotic reactions of pilots and members of airplane crews.

Although intended primarily for the information of medical psychiatrists, the text covers a wide range of abnormal conditions and indicates applications to civilian psychiatry, as well as general social implications.

This type of study is important to a better understanding of one of the most serious of postwar problems—the treatment of those who have suffered nervous and mental shocks. The Blakiston Company, Philadelphia, 1945; 484 pages, $5.00.

Meteorology for Pilots

Robert W. Mudge

Contents: Basic Physical Concept; Circulation; Stability; Air Masses; Fronts; Fogs; Icing; Thunderstorms, Hurricanes, and Tornadoes; Clouds; Information Available to Pilots, and Its Use; Forecasting; Forecasting from Local Indications; Flight Planning.

In this text intended especially for pilots, the author's aim has been to provide a simplified explanation of meteorologic theory and its application to flight operations. The book explains why phenomena occur, gives specific suggestions for flying in various kinds of weather, and discusses the interpretation and use of weather information for flight planning. The author has included material to assist the pilot in flying safely, efficiently, and comfortably.

The use of formulas is avoided. Following each theoretic presentation is an explanation of its importance to the pilot and suggestions regarding appropriate flight procedures utilizing the principle under review. McGraw-Hill Book Company, Inc., New York, 1945; 259 pages, $3.00.

With the exception of aeronautical annuals and books published outside the United States, books reviewed in this section may be borrowed without charge from The Paul Kollsman Library of the Institute of the Aeronautical Sciences, 1505 RCA Building West, 30 Rockefeller Plaza, New York 20, N. Y.

Principles and Practices of Inhalational Therapy

Alvan L. Barach

Contents: Historical and Physiologic Background of Inhalational Therapy; Acute Altitude Sickness, Acute Anoxia; Pneumonia; Edema of the Lungs; Congestive Heart Failure; Coronary Thrombosis and Coronary Sclerosis; Shock; Pulmonary Infarction; Massive Collapse of the Lung; Postoperative Atelectasis; Bronchial Asthma; Obstructive Lesions in the Larynx, Trachea, and Bronchi; Pulmonary Emphysema; Accidental Asphyxia; Asphyxia of the Newborn: Antenatal Fetal Anoxia and Atelectasis of the Lungs of the Newborn; Hemorrhage; Peripheral Arteriosclerosis; Migraine, Seasickness, Gas Gangrene, and Tetanus; Anesthesia and Anoxia; Aero-Embolism; War Gas Poisoning and Lung Irritants; Postencephalographic Headache; Anoxia and Brain Lesions Following Fever Therapy; Head Injuries; Paralysis of the Respiratory Musculature; Cerebral Embolism and Thrombosis; Chronic Pulmonary Tuberculosis; Blast Injuries of the Lungs; Aerial Transportation of Patients with Miscellaneous Diseases; Oxygen Poisoning; Submarine Medicine and Caisson Disease; Hiccough; Some Considerations Concerning Research in Respiratory Function and Inhalational Therapy; Methods of Inhalational Therapy; Care of Inhalational-Therapy Equipment; Respirators; Oxygen Analyzers; An Accurate Method for Obtaining the Oxygen and Carbon-Dioxide Concentration of the Inspired Air in Oxygen Masks and Other Oxygen-Therapy Equipment.

For those who are responsible for the therapeutic use of gases in clinical medicine and in many phases of war medicine, this book provides an understanding of the physiologic basis as well as the techniques of inhalational therapy. The present and future state of the therapeutic uses of gases is discussed. Methods of inhalational therapy are set forth in considerable detail in order to provide the physician in charge with the knowledge required to select apparatus and use it efficiently. J. B. Lippincott Company, Philadelphia, 1944; 315 pages, $4.00.

Book Notes

International Airways, compiled by Alberta Worthington; The H. W. Wilson Company, New York, 1945; 275 pages, $1.25.

A compilation of articles and excerpts contains a series of discussions limited to the commercial aspects of international aviation. One series treats of national viewpoints, another takes up the controversial subject of the "chosen instrument" or single subsidized international air line. The concluding series is concerned with the International Civil Aviation Conference held in Chicago in 1944. To these is added the *Convention on International Civil Aviation* and the *International Air Transport Agreement.* A bibliography on international commercial aviation gives further reference source material.

Postwar Goals and Economic Reconstruction, edited by Arnold J. Zurcher and Richmond Page; New York University, Institute on Postwar Reconstruction, New York, 1944; 305 pages, $3.50.

At New York University's Conference on Postwar Reconstruction, a distinguished group of speakers discussed various problems of reconversion. Many of these papers have a timely interest for those who are engaged in making postwar decisions.

Sixty Million Jobs, by Henry A. Wallace; Simon and Schuster, New York, 1945; 83 pages, $1.00.

The Secretary of Commerce presents his ideas about the possibilities of a national production of at least $200,000,-

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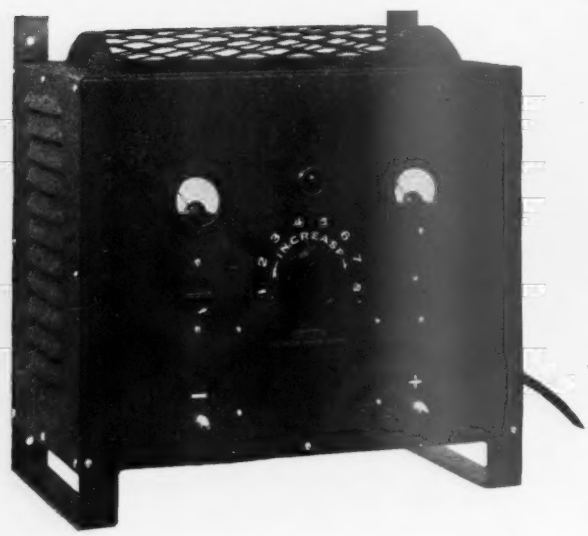

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12VA10§	12	10	14	10	15	18	32 lbs.
24VA10§	24	10	20	12	15	18	60 lbs.
32VA10§	32	10	20	12	15	18	75 lbs.
6VA25‡	6	25	17	14	24	28	45 lbs.
12VA25‡	12	25	17	14	24	28	72 lbs.
24VA25§‡	24	25	24	16	24	28	140 lbs.
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000,000 and full employment of 60,000,000 people by 1950. Stating that he has recently become interested in aviation, Mr. Wallace indicates the need for a nation-wide system of modern airports to facilitate the development of private flying. He looks forward to the day when the private owner will be able to fly his own light plane from Buenos Aires to Alaska, with airports spaced every few hundred miles along the way.

Women in Aviation, by Betty Peckham; Thomas Nelson & Sons, New York, 1945; 164 pages, $2.50.

The many kinds of work women can do in aviation and the qualifications required for various occupations are outlined in this book. Although originally intended as a guide for women seeking employment in some phase of aircraft war work, the book will have even greater value for women who wish to engage in peacetime aviation with the scope of jobs for women constantly widening. Prospective employees are provided with information by which they can determine their qualifications.

Hydrodynamics, by Sir Horace Lamb; Dover Publications, New York, 1945; 738 pages, $4.95.

The mathematical theory of the motion of fluids is dealt with in this treatise which should be found useful in the solving of certain problems of aeronautics. Although regarded as the sixth edition of a *Treatise on the Mathematical Theory of the Motion of Fluids* first published in 1879, it is the first American edition.

In the current edition, no change has been made in the general plan and arrangement but the text has been revised throughout, certain important omissions have been corrected, and new matter has been added.

High-Pressure Die Casting, by H. L. Harvill and Paul R. Jordan; H. L. Harvill Manufacturing Company, Vernon, Calif., 1945; 130 pages.

Design data and information about the die casting processes are supplied in this book. The two basic types are defined as the hot-chamber, low-pressure method and the cold-chamber, high-pressure method. Most of the text is given to the cold chamber, high-pressure process. Subjects considered include the materials used in die casting, the construction and operation of dies, the design of parts for die casting, and the machining, finishing, and inspection of die castings. A glossary of die casting terminology is included.

The Electrolytic Capacitor, by Alexander M. Georgiev; Murray Hill Books, Inc., New York, 1945; 191 pages, $3.00.

The author describes the construction, manufacture, function, and testing of dry and wet electrolytic capacitors. He explains the operating characteristics of the various types of capacitors and indicates their useful applications and limitations. A glossary of technical terms and a bibliography accompany the text.

Private Pilot Examination and Instruction Covering New Civil Air Regulations, by Charles A. Zweng; Pan American Navigation Service, North Hollywood, Calif., 1945; 34 pages, $1.00.

A manual arranged in question-and-answer form intended especially to help candidates for the private pilot and other airman ratings to prepare for the written examination under the new Civil Air Regulations effective July 1, 1945.

Sections refer to the Air Traffic Rules and General Operation Rules, and a typical "multiple choice" examination is reproduced with the correct answers. A special set of questions and answers is applicable to Section 20 of the Civil Air Regulations, for candidates for pilot certificates.

Report on the Measurement of Surface Finish by Stylus Methods, by R. E. Reason, M. R. Hopkins, and R. I. Garrod; Taylor, Taylor & Hobson Ltd., Leicester, England, 1944; 89 pages, 30*s*.

Research on the measurement of surface finish by stylus methods carried out at the Taylor-Hobson Research Laboratory is reported in this book. The report is a review of research work bearing on the everyday use of stylus instruments and comprises a study of the nature of the surface and the many kinds of imperfections that need to be measured; the basic elements of the stylus instrument and its limitations, particularly the limitations imposed on the graph; and ways in which a numerical assessment may be secured.

The Machinists' and Draftsmen's Handbook, by Albert M. Wagener and Harlan R. Arthur; D. Van Nostrand Company, Inc., New York, 1945; 662 pages, $4.50.

Basic information required by machinists and draftsmen for the mathematical computations entailed in their daily work is supplied in this reference book. In order to keep the book down to a convenient size, the authors have made a critical selection of pertinent material. The solutions to elementary mathematical problems are set forth in considerable detail. Problems involving measurements of plane and solid geometric figures, weights and measures, and the fundamental mechanical devices are studied, as well as strength of materials, the laws of mechanics, and the operating principles of common shop machines. Tables of dimensions and properties, and other mechanical data are reproduced.

Problems in Engineering Drawing, Series 1, by A. S. Levens and A. E. Edstrom; McGraw-Hill Book Company, Inc., New York, 1945; various paging, $2.50.

This set of engineering drawing problems has been issued for use with the book titled *Engineering Drawing*, by Thomas E. French, Sixth Edition. It is a workbook that has been designed especially to meet the requirements of the student in engineering drawing.

Mechanical Springs, by A. M. Wahl; Penton Publishing Company, Cleveland, 1944; 435 pages, $6.00.

The fundamental principles underlying the design of mechanical springs are set forth in this book. Information is given concerning important developments in spring theory and testing which have taken place in recent years. Emphasis is placed on the importance of considering the limitations of materials when designing springs, and the stresses set up during their operation. Because of the importance of the helical compression or tension spring, a relatively large amount of space is assigned to this type. The volute type of spring is treated in considerable detail because of its military applications. Other types of springs studied include disc, Belleville, flat, leaf, torsion, and ring springs. There is also a chapter on rubber springs.

The Chemical Constituents of Petroleum, by A. N. Sachanen; Reinhold Publishing Corporation, New York, 1945; 451 pages, $8.50.

The analytic aspects of petroleum chemistry and the individual hydrocarbons and other chemical constituents of petroleum are studied in this extensive text. Data on the content of the various types of hydrocarbons and other constituents, expressed in terms of ring analysis and of conventional classes, together with methods of determining the structures and classes, make up a large portion of the volume.

Sections deal with petroleum gases and natural gasolines; physical and chemical methods of determining hydrocarbons in distillates; the hydrocarbons of straight-run and synthetic distillates; petroleum wax; oxygen, sulphur, and nitrogen compounds; resins and asphaltic products; and the classification of crude oils.

Medical Physics, Otto Glasser, Editor-in-Chief; The Year Book Publishers, Inc., Chicago, 1944; 1,744 pages, $18.

This book offers an extensive treatment of the subject of medical physics in the form of a compilation of contributions by specialists in their particular fields. The editors' object has been to produce a combination of an encyclopedia, sufficiently comprehensive to serve as a reference for those whose occupations involve any aspect of medical physics; a textbook, adequately detailed in exposition to serve students; and a working instrument in which may be found the data necessary for actual application of the principles of physics to medicine.

The volume contains 256 articles and papers on subjects classified under anatomy, bacteriology, biometrics, biophysics, dermatology, hematology, medicine, neurology, nuclear physics, ophthalmology, optics, orthopedics, otolaryngology, pathology, pediatrics, photography, physical chemistry, physical therapy, physics (instruments and methods), physiology, radiology, surgery, and urology.

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Spherical Trigonometry after the Cesàro Method, by J. D. H. Donnay; Interscience Publishers, Inc., New York, 1945; 83 pages, $1.75.

Written to serve as a text in a one-unit course for a college quarter or semester, this book contains concise information about spherical trigonometry which can be imparted in ten or twelve lectures. The author regards the Cesàro method as particularly suitable because it is straightforward and timesaving. While the order in which the subject matter is arranged may appear unorthodox, it is stated to have been found satisfactory from the teaching point of view. Among the engineers and other scientists for whom the book is intended are naval and aviation officers, for use in the solution of navigation problems.

Transmission Lines, Antennas and Wave Guides, by Ronold W. P. King, Harry Rowe Mimno, and Alexander H. Wing; McGraw-Hill Book Company, Inc., New York, 1945; 347 pages, $3.50.

This book contains the material given in the lectures on transmission lines, antennas, wave guides, and wave propagation, which constituted part of a course of instruction in preradar training for officers in the armed forces, given at Cruft Laboratory by the Graduate School of Engineering of Harvard University. Transmission lines are treated exclusively from the high-frequency point of view; antennas are described from the point of view of electromagnetic theory; and wave guides are presented from the point of view of generalized transmission circuits. A brief treatment of wave propagation is included.

The Model Plane Annual, 1945, edited by David C. Cooke; Robert M. McBride & Company, New York, 1945; 192 pages, $3.00.

Special chapters devoted to microfilm for models, model-building tips, and miniature gasoline engine terms have been added to the 1945 edition of this annual for model-airplane builders. The book also contains both flying and nonflying model plans, plans of famous aircraft, and other information for the model builder.

With emphasis on building instruction and the technique of building, flying, and servicing of model aircraft, the book has advanced to the status of a builders' handbook, although it is still written for those who build model airplanes as a hobby rather than for those who regard the work from the engineer's standpoint.

Applied Mathematics for Radio and Communication Engineers, by Carl E. Smith; McGraw-Hill Book Company, Inc., New York, 1945; 336 pages, $3.50.

The principles of mathematics used in radio and communication engineering are explained in this book. The material is arranged so that the fundamentals may be mastered easily by self-study. Each theory is developed inductively by building from the simple basic fundamentals to the more elaborate detailed concepts. The theory is then applied to the development of useful design equations. Examples are supplied to aid the student in the practical application of the principles learned. A simple treatment of calculus and chapters on series and wave forms are included.

Making Patent Drawings, by Harry Radzinsky; The Macmillan Company, New York, 1945; 96 pages, $3.00.

A newly published handbook gives information about the preparation of patent drawings. Explicit instructions are given for shading in the form peculiar to patent drawings and for the proper placement of numerals and figures. Special techniques used in making drawings for patents and trademarks are described. Practical advice is given regarding the use of drawing materials. The book explains how to avoid faults or defects in drawings which might cause them to be rejected by the Patent Office.

Aeronautical Instrument Projects for Junior Aviation Classes, by Walter B. Weber; McKnight & McKnight, Bloomington, Ill., 1945; 124 pages, $1.20.

The purpose of this book is to provide high-school students taking preflight courses with a simplified explanation of aeronautical instruments. Instructions are given for the construction of model instruments that illustrate the principles involved. A section of the book is given to the construction of radio communication instruments because of the important part they play in assisting the pilot to fly.

Machine Design, by P. H. Hyland and J. B. Kommers; McGraw-Hill Book Company, Inc., New York, 1943; 562 pages, $4.50.

New material and a complete set of new problems have been added to this third edition of a book on machine design. Because old material has been omitted, the number of pages has been kept within the limits of the second edition. The book has been written to provide a text from which to teach the elements of machine design and is not intended for use as a reference book.

The Theoretical Behavior and Design of Initially Curved Struts Under an Intermediate Concentric Axial Load, by Sergius Ivan Sergev; University of Washington, Engineering Experiment Station, Seattle, 1945; 32 pages.

Bulletin No. 113 of the Engineering Experiment Station Series contains a study of the theoretic behavior and design of slightly curved struts pin-supported at one end, laterally supported at the other, and loaded by a single concentric axial load applied at some intermediate point between the supports. Equations are derived for different but constant cross sections below and above the load. Steel struts, with a constant cross section throughout and loaded at the midpoint, are solved in detail.

Optical Instruments, by Earle B. Brown; Chemical Publishing Company, Inc., Brooklyn, N.Y., 1945; 567 pages, $10.

Basic principles of optical-instrument design are explained in this text. Information is given about the adjustment of the various types of instruments. Emphasis is placed on the telescope because the majority of optical instruments are telescopic in principle. Details are given about the design of the spectroscope, the range finder, and other instruments. Extensive material on the care and maintenance of optical instruments is included. Appendixes contain mathematical formulas and proofs used in the optical sciences and a glossary of optical-instrument terms.

Male Call, by Milton Caniff; Simon and Schuster, New York, 1945; 1 volume, $1.00.

A collection of 112 comic strips prepared for the entertainment of Army men. These appeared originally in Army camp or unit newspapers.

A Survey in Seating; Harvard University, Department of Anthropology, Statistical Laboratory, Cambridge, Mass., 1945; 101 pages, free.

The results of a detailed analysis of railway-coach seating, conducted by Earnest A. Hooton and a Harvard University staff, are reported in this book. The investigation was undertaken to determine the dimensions of railway-coach seats which would fit them to the majority of passengers. The principles outlined are stated to have been used by the Army Air Forces in designing seating arrangements in aircraft and they may be applicable to passenger-aircraft design work.

Electronics Laboratory Manual, by Ralph R. Wright; McGraw-Hill Book Company, Inc., New York, 1945; 77 pages, $1.00.

Written to serve as a laboratory textbook, this manual is intended for electrical engineering students who are taking their first course in electronics. The twelve basic experiments described are designed to acquaint the student with the characteristics, principles of operation, and applications of electron tubes. Each experiment is explained in considerable detail, so that the student may understand the reasons for the procedure followed and the observations made, and draw logical conclusions from his laboratory work.

An Introduction to Mechanics, by J. W. Campbell; Edwards Brothers, Inc., Ann Arbor, Mich., 1944; 288 pages, $3.75.

Although written especially for first- and second-year students of applied science, this introduction to mechanics is also suitable for use in an intermediate mechanics course as given in many departments of physics. The first part of the book has been completely revised, vector notation has been introduced, and a chapter on gravitation has been added.

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The services of the Aeronautical Archives are available to all members of the Institute, to Corporate Members, to advertisers in the AERONAUTICAL ENGINEERING REVIEW and, under usual library limitations to the public. Four specialized services are available.

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Applications for membership in the library and further information will be sent on request.

The Burden Reference Library

This reference library contains over 12,000 aeronautical books, magazines, pamphlets, and reports gathered from world-wide sources and is one of the most complete aeronautical libraries in the world. Material from this library is not available for loan but may be used for reference purposes at the Aeronautical Archives.

The Pacific Aeronautical Library

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Established in cooperation with the aircraft companies the library serves. The leading aircraft companies in or near Los Angeles participate in its support and operation.

This service library for aeronautical research is available to the public for reading privileges. Source material includes aerodynamic and structural research reports, as well as books on drafting, production methods, history, and allied sciences. It furnishes books, periodicals, and pamphlet material to the participating aircraft companies to supplement their engineering libraries.

The Aeronautical Archives Technical Information Service

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Source Material

For the information of readers, the following lists the periodicals, house organs, and other publications regularly received and reviewed.

The prices listed are for single issues and yearly subscriptions to recipients in the United States. Subscription prices to house organs are in many cases not available but may be obtained directly from the offices of the organization.

The frequency of publication is indicated by the following symbols: M, monthly; SM, semimonthly; BM, bimonthly; W, weekly; BW, biweekly; D, daily; Irreg., irregularly; Q, quarterly.

Periodicals

Aero Digest, 515 Madison Ave., New York 22, N.Y., SM, $0.50, $3.00.

The Aero Field, Francis J. Field, Ltd., Sutton Coldfield, England, 10 issues per year, 6*d*., 5*s*.

Aero Products, 271 Madison Ave., New York 16, N.Y., M.

Aeromodeller, Wilmary House, Merton Lane, Highgate, London, N. 6, M, 1*s*., 15*s*.

Aeronáutica, Avda. de Mayo 1370, Buenos Aires, M, $0.60 (pesos), $4.50 (pesos).

Aeronautics, Tower House, Southampton St., Strand, London, W.C.2, M, 2*s*., 26*s*. 6*d*.

The Aeroplane, Bowling Green Lane, London, E.C.1, W, 1*s*., 58*s*.

The Aeroplane Spotter, Bowling Green Lane, London, E.C.1, BW, 3*d*., 8*s*. 8*d*.

Air Age Education News, Air Age Education Research, 100 E. 42d St., New York 17, N.Y., BM.

Air Facts, 30 Rockefeller Plaza, New York 20, N.Y., M, $0.25, $3.00.

Air Mail Magazine, A. Phillips, Newport, Monmouthshire, M, 4*d*., 5*s*.

Air News, 545 5th Ave., New York 17, N.Y., M, $0.20, $2.00.

Air Trails Pictorial, 122 E. 42d St., New York 17, N.Y., M, $0.25, $2.50.

Air Transport, 330 W. 42d St., New York 18, N.Y., M, $0.50, $5.00.

Air Transportation, 10 Bridge St., New York 4, N.Y., M, $0.50, $5.00.

Air World, 241 Church St., New York 13, N.Y., BM, $0.15, $0.90.

Aircraft, 62 Flinders St., Melbourne, C.1, M, 1*s*. per issue.

Aircraft Engineering, 12 Bloomsbury Sq., London, W.C.1, M, 2*s*. 3*d*., 26*s*.

Aircraft Production, Dorset House, Stamford St., London, S.E.1, M, 2*s*. 6*d*., £1 14*s*. 6*d*.

Airlanes, 340 W. 57th St., New York 19, N.Y., M, $0.25, $2.50.

Airmail Digest, Charles B. Charmatz, Sylvania, Ohio, Irreg.

Airports, 1170 Broadway, New York 1, N.Y., M, $0.25, $3.00.

Aluminum and Magnesium, 425 W. 25th St., New York 1, N.Y., M, $3.00 yr.

American Aviation, American Bldg., Washington 4, D.C., SM, $0.25, $4.00.

American Aviation Daily, American Bldg., Washington 4, D.C., D, $170 yr.

American Aviation Directory, American Bldg., Washington 4, D.C., Semi-annually, $5.00, $7.50.

American Aviation Traffic Guide, 139 N. Clark St., Chicago 2, Ill., M, $0.50, $5.00.

The American Mercury, 570 Lexington Ave., New York 22, N.Y., M, $0.25, $3.00.

Automotive and Aviation Industries, Chestnut & 56th Sts., Philadelphia 22, Pa., SM, $0.25, $1.00.

Avia, Victoria 788, Buenos Aires, M, $0.50 (*m/n*), $5.00 (*m/n*).

Aviação, Rua Uruguiana, 104, Rio de Janeiro, M, $4.00 (cruzeiros), $40 (cruzeiros).

Aviación, 429 H. W. Hellman Bldg., Los Angeles 13, Calif., BM, $1.00 yr.

Aviation, 330 W. 42d St., New York 18, N.Y., M, $0.50, $3.00.

Aviation and Yachting, 2816 Eaton Tower, Detroit 26, Mich., M, $0.25, $2.00.

Aviation Equipment, 1170 Broadway, New York 1, N.Y., M.

Aviation Maintenance, 205 E. 42d St., New York 17, N.Y., M, $0.50, $5.00.

Aviation News, 1357 National Press Bldg., Washington 4, D.C., W, $0.50, $5.00.

Aviation Review, 31 Willcocks St., Toronto 5, Ontario, M, $0.25, $3.00.

Aviation Service Magazine, 549 W. Washington Blvd., Chicago 6, Ill., BM.

British Plastics, Dorset House, Stamford St., London, S.E.1, M, 1*s*. 6*d*., 20*s*.

Canadian Air Cadet, 122 Wellington St., Ottawa, Ontario, M, $0.10, $1.00.

Canadian Aviation, 481 University Ave., Toronto 2, Ontario, M, $0.25, $2.00.

Chile Aéreo, Club Aéreo de Chile, Av. Bulnes 80, Santiago de Chile, M, $5.00 (pesos), $50 (pesos).

Collier's, The Crowell-Collier Publishing Co., Springfield, Ohio, W, $0.10, $3.00.

Commercial Aviation, 341 Church St., Toronto, Ontario, M, $0.25, $3.00.

Contact, 113 W. 42d St., New York 18, N.Y., M, $0.20, $2.00.

Cross Country News, M. I. Hall, 1007-A 13th St., Lubbock, Tex., W, $5.00 yr.

Current Aviation, 400 S. Front St., Columbus 15, Ohio, W, $0.80 yr.

Diesel Power & Diesel Transportation, 192 Lexington Ave., New York 16, N.Y., M, $0.35, $3.00.

Distribution Age, 100 E. 42d St., New York 17, N.Y., M, $0.30, $3.00.

EMCO Monthly Journal, Marks Stamp Co., Ltd., 258 College St., Toronto 2, Ontario, M, $0.50 yr.

The Engineer, 28 Essex St., Strand, London, W.C.2, W, 1*s*., £3 3*s*.

Engineering, 35 Bedford St., Strand, London, W.C.2, W, 1*s*. 2½*d*., £3 3*s*.

Engineering Materials and International Power Review, Africa House, Kingsway, London, W.C.2, BM, 3*s*., 15*s*.

Engineering News-Record, 330 W. 42d St., New York 18, N.Y., W, $5.00 yr.

The Engineers' Digest (American Edition), 1 Madison Ave., New York 10, N.Y., M, $0.75, $7.50.

Flight, Dorset House, Stamford St., London, S.E.1, W, 1*s*., £3 1*s*.

Flying, 185 N. Wabash Ave., Chicago 1, Ill., M, $0.35, $4.00.

Flying Age, 67 W. 44th St., New York 18, N.Y., M, $0.15, $1.80.

Gliding, 4658 Portage Rd., Kalamazoo 85, Mich., M, $0.25, $3.00.

Heating and Ventilating, 148 Lafayette St., New York 13, N.Y., M, $0.30, $2.00.

Indian Aviation, 13 Ezra Mansions, P.O. Box 2361, Calcutta, India, M, 8 annas, 7 rupees 8 annas.

Industrial Aviation, 185 N. Wabash Ave., Chicago 1, Ill., M, $2.00 yr.

Industrial Engineering, 416 Wall St., Los Angeles 13, Calif., M, $2.00 yr.

Industrial Standardization, American Standards Assn., 70 E. 45th St., New York 17, N.Y., M, $0.35, $4.00.

Instruments, 1117 Wolfendale St., Pittsburgh 12, Pa., M, $2.00 yr.

International Aviation (Foreign News Supplement to American Aviation Daily), American Building, Washington 4, D.C., W, $100 yr.

Iron Age, 100 E. 42d St., New York 17, N.Y., W, $0.35, $8.00.

Kunststoffe, Edwards Bros., Inc., 300 John St., Ann Arbor, Mich., M, $15 yr.

Light Metals, Bowling Green Lane, London, E.C.4, M, 1*s*. 6*d*., 20*s*.

Luftfahrtforschung, Edwards Bros., Inc., 300 John St., Ann Arbor, Mich., M, $12 yr.

Machine Design, Penton Bldg., Cleveland 13, Ohio, M, $0.50, $6.00.

Machinery, 148 Lafayette St., New York 13, N.Y., M, $0.40, $4.00.

Mechanix Illustrated, 1501 W. Broadway, New York 18, N.Y., M, $0.15, $1.80.

Metals and Alloys, 330 W. 42d St., New York 18, N.Y., M, $0.25, $2.00.

The Military Surgeon, Army Medical Museum, Washington 25, D.C., M, $0.50, $4.00.

Model Airplane News, 551 5th Ave., New York 17, N.Y., M, $0.20, $2.00.

Modern Metals, Burnham Bldg., Chicago 1 Ill., M, $3.00 yr.

Modern Plastics, 122 E. 42d St., New York 17, N.Y., M, $0.50, $5.00.

Modern Transport, 105–109, Strand, London, W.C.2, W, 3*d*., 20*s*.

Mundo Aeronáutico, Rivadavia 945, Buenos Aires, M, $0.30 (pesos), $4.00 (pesos).

The N.A.T.A. Dispatch, National Aviation Trades Assn., 214 E. Armour Blvd., Kansas City 2, Mo., 36 issues per yr.

Official Aircraft Price Guide, Aircraft Advisory Service, Inc., P.O. Box 81, Columbus 16, Ohio, Q, $6.50 yr.

The Official Foreign Air Mail Guide, 11 W. 42d St., New York 18, N.Y., M, $1.50 yr.

The Official Guide of the Airways, 608 S. Dearborn St., Chicago 5, Ill., M, $0.50, $5.00.

Pacific Plastics, 124 W. 4th St., Los Angeles 13, Calif., M, $0.30, $3.00.

Plastics, 540 N. Michigan Ave., Chicago 11, Ill., M, $5.00 yr.

Plastics, Bowling Green Lane, London, E.C.1, M, 1*s*. 6*d*., 19*s*.

Plastics and Resins, 299 Madison Ave., New York 17, N.Y., M, $0.35, $3.00.

Plastics Reporter, 1214 Hyde Park Ave., Hyde Park 36, Mass., M, $0.20, $2.00.

Plastics World, 551 5th Ave., New York 17, N.Y., M, $0.25, $3.00.

Popular Mechanics Magazine, 200 E. Ontario St., Chicago 11, Ill., M, $0.25, $2.50.

Popular Science Monthly, 353 4th Ave., New York 10, N.Y., M, $0.25, $2.50.

Product Engineering, 330 W. 42d St., New York 18, N.Y., M, $0.50, $5.00.

Production Equipment, 328 S. Jefferson St., Chicago 6, Ill., M.

Protar, Buchdruckerei Vogt-Schild AG., Solothurn, M, 1.00 Sw. Fr., 15 Sw. Fr.

Recent Periodical Articles, Library, Parks Air College, Inc., E. St. Louis, Ill., M, $5.00 yr.

Revista Aérea Cubana, O'Reilly 170, Habana, Cuba, M, $0.10, $1.00.

Revista Aérea Latinoamericana, 515 Madison Ave., New York 22, N.Y., M, $0.15, $1.00.

Revista do Ar, Aero Clube de Portugal, Av. da Liberdade, 226, Lisboa, M, 120$00.

România Aeriană, Calea Floreasca Nr. 13, Bucharest, M.

Rutas del Aire, Melincué 2501, Buenos Aires, M, $0.30 (*m/n*), $3.50 (*m/n*).

The Saturday Evening Post, Independence Sq., Philadelphia 5, Pa., W, $0.10, $6.00.

Schweizer Aero-Revue, Hirschengraben 22, Zürich, M, 80 Rappen, 10 Sw. Fr.

Science Illustrated, 345 Hudson St., New York 14, N.Y., M, $0.25, $3.00.

Scientific American, 24 W. 40th St., New York 18, N.Y., M, $0.35, $4.00.

Sheet Metal Industries, 49, Wellington St., London, W.C.2, M, 1*s*. 3*d*., 15*s*.

Skyways, 444 Madison Ave., New York 22, N.Y., M, $0.25, $3.00.

Southern Flight, 1901 McKinney Ave., Dallas 1, Tex., M, $0.25, $2.00.

Steel Processing, 108 Smithfield St., Pittsburgh 30, Pa., M, $0.25, $2.50.

Trade-a-Plane Service, Crossville, Tenn., 3 issues per month, $0.25 yr.

U. S. Air Services, Transportation Bldg., Washington 6, D.C., M, $0.25, $3.00.

V.D.I. Zeitschrift, Edwards Bros., Inc., 300 John St., Ann Arbor, Mich., W, $19 yr.

Velocidade, rua Conselheiro Chrispiniano, 90, São Paulo, Brazil, M, Cr. $2.50, Cr. $30.

Western Flying, 304 S. Broadway, Los Angeles 13, Calif., M, $0.25, $2.00.

Whites Aviation, 605 Dilworth Bldg., Auckland, C.1, N.Z., M, 1*s*. (U.S. distributors, American Aviation Associates, American Bldg., Washington 4, D.C., $3.00 yr.)

Wings, McGraw-Hill Publishing Co., Inc., 330 W. 42d St., New York 18, N.Y., M.

Wings, 1 Marion St., Wellington, N.Z., M, 6*d*., 10*s*.

Wings, London House, 21 Loveday St., Johannesburg, Union of South Africa, M, 6*d*., 7*s*. 6*d*.

Society and University Publications

Accelerator, Metropolitan Section, Society of Automotive Engineers, Inc., 29 W. 39th St., New York 18, N.Y., 10 issues per yr.

Aero Mechanic, Aircraft Builders Lodge 751, A. F. of L., 5513 Airport Way, Seattle 8, Wash., W, $1.50.

Aeronautical Briefs, Aeronautical Chamber of Commerce of America, Inc., 610 Shoreham Bldg., Washington 5, D.C., M.

Aeronautical Chamber of Commerce of America, Inc., Weekly Washington Bulletin, 610 Shoreham Bldg., Washington 5, D.C., W.

Aeronautical Engineering Review, Institute of the Aeronautical Sciences, Inc., 1505 RCA Bldg. West, 30 Rockefeller Plaza, New York 20, N.Y., M, $0.30, $3.00.

The Air Force Woman, The National Assn. of Air Forces Women, 1702 K St., N.W., Washington 6, D.C., M.

The Air Line Mechanic, The Air Line Mechanics Assn., International, 155 N. Clark St., Chicago 1, Ill., M.

The Air Line Pilot, The Air Line Pilots Assn., International, 3145 W. 63d St., Chicago 29, Ill., M.

Air Power League, Bulletin, 350 5th Ave., New York 1, N. Y., M.

Air Training Corps Gazette, Published for the Air League of the British Empire by The Rolls House Publishing Co., Ltd., 2 Breams Bldgs., London, E. C. 4, M, 6*d*., 7*s*.

Air Transport Safety, National Safety Council, 20 North Wacker Drive, Chicago 6, Ill., M.

Airport Digest, National Aeronautic Assn., 1025 Conn. Ave., N.W., Washington 6, D.C., M.

Airpost Journal, American Air Mail Society, Albion, Pa., M, $0.20, $2.00.

American Aeronaut, Aeronautical Industrial District Lodge 727, International Assn. of Machinists, 5501 Lankersheim, North Hollywood, Calif., W, $0.03, $1.50.

American Helicopter Society, Semi-Technical Bulletin, Newfield P.O. Box 4029, Bridgeport 7, Conn., Irreg., $0.50 per issue.

American Meteorological Society, Bulletin, Milton, Mass., M, $0.35, $3.50.

American Rocket Society, Journal (formerly Astronautics), 130 West 42d St., New York 18, N.Y., Q, $1.50, $4.00.

American Society for Testing Materials, Bulletin, 260 S. Broad St., Philadelphia 2, Pa., BM, $0.25, $1.50.

American Society of Mechanical Engineers, Transactions, 29 W. 39th St., New York 18, N.Y., M, $1.50, $12.

Army Ordnance, Army Ordnance Assn., 705 Mills Bldg., Washington 6, D.C., BM, $0.75, $4.50.

Astro-Jet, Glendale Rocket Society, 3262 Castera Ave., Glendale 8, Calif., 3 issues per yr., $1.00 yr.

Automotive War Production, Automotive Council for War Production, New Center Bldg., Detroit 2, Mich., M.

Aviation Progress, County Chamber of Commerce, Los Angeles, Calif., M.

Aviation Writers Assn., Newsletter, P.O. Box 856, Grand Central Annex, New York 17, N.Y., Irreg.

Boletín de Aviación, National Aeronautic Assn., 1025 Conn. Ave., N.W., Washington 6, D.C., M.

Chirp, The Early Birds, Lt. Col. Ernest Jones, Secretary, 3401 16th St., N.W., Washington, D.C., Irreg.

Civil Air Patrol League, News, 545 5th Ave., New York 17, N.Y., M.

Combined British Astronautical Societies, Official Bulletin, 26, Chesterford Gardens, Hampstead, London, N.W.3, M.

Conference of International Air Traffic Operators, Bulletin, 31-32, Haymarket, London, S.W.1, M, 1*s*., 10*s*. 6*d*.

Electrical Engineering, American Institute of Electrical Engineers, 33 W. 39th St., New York 18, N.Y., M, $1.50, $12.

Faraday Society, Transactions, 98 Great Russell Street, London, W.C.1, M, 5*s*. per issue.

Fasteners, American Institute of Bolt, Nut and Rivet Manufacturers, 1550 Hanna Bldg., Cleveland 15, Ohio, Q.

For Your Information, National Aeronautic Assn., 1025 Conn. Ave., N.W., Washington 6, D.C., W.

The Foundation, Engineering Society of Detroit, 100 Farnsworth Ave., Detroit, Mich., M.

The Franklin Institute, Journal, Benjamin Franklin Parkway at 20th St., Philadelphia, Pa., M, $0.60, $6.00.

Haul Down and Ease Off, National Assn. of American Balloon Corps Veterans, P.O. Box 2040, Wichita, Kan., BM.

Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2, Ill., M, $0.25, $2.00.

Industrial Quality Control, Published by the Society of Quality Control Engineers in cooperation with the University of Buffalo, Crosby Hall, University of Buffalo, Buffalo 14, N.Y., BM, $1.25, $6.00.

Institute of Radio Engineers, Proceedings, 330 W. 42d St., New York 18, N.Y., M, $1.00, $10.

Institute of Transport, Journal, 15 Savoy St., Victoria Embankment, London, W.C.2, Q, 2*s*. 6*d*. per issue.

The Institute of Welding, Transactions, 2, Buckingham Palace Gardens, London, S.W.1, Q, 10*s*. 6*d*. per issue.

The Institution of Mechanical Engineers, Journal and Proceedings, Storey's Gate, St. James's Park, London, S. W. 1, 35*s*. yr.

Journal of Aeronautical Meteorology, Meteorological Committee, Air Transport Association of America, 10 Richards Road, Kansas City 6, Mo., Q, $0.50, $2.00.

Journal of Applied Mechanics, 29 W. 39th St., New York 18, N.Y., Q, $1.35, $5.00.

Journal of Applied Physics, 57 E. 55th St., New York 22, M, $0.70, $7.00.

Journal of Aviation Medicine, Aero Medical Assn. of the United States, 2642 University Avenue, St. Paul 4, Minn., BM, $1.25, $5.00.

The Journal of Engineering Education, Prince and Lemon Sts., Lancaster, Pa., 10 issues per year, $0.50, $3.00.

The Journal of Meteorology, American Meteorological Society, Milton 86, Mass., Q, $6.00 yr.

Journal of Scientific Instruments, 19, Albemarle St., London, W.1, M, 3*s*. 4*d*., 40*s*.

Journal of the Aeronautical Sciences, Institute of the Aeronautical Sciences, Inc., 1505 RCA Bldg. West, 30 Rockefeller Plaza, New York 20, N.Y., Q, $2.00, $7.00.

The Log, The British Air Line Pilots' Assn., 7, Park Lane, London, W.1, M.

MagNEWSium, The Magnesium Assn., 30 Rockefeller Plaza, New York 20, N.Y., Q.

Mechanical Engineering, American Society of Mechanical Engineers, Inc., 29 W. 39th St., New York 18, N.Y., M, $0.75, $6.00.

Metropolitan Airmail Cover Club, Bulletin, The Malin Studios, 225 W. 46th St., New York 19, N.Y., M.

Model Aviation, Air Youth Div., National Aeronautic Assn., 1025 Connecticut Ave., Washington 6, D.C., M, $1.00.

National Aeronautics, National Aeronautic Assn., 1025 Conn. Ave., Washington 6, D.C., M, $6.00 yr.

New York University, Contributions from the College of Engineering, University Heights, New York 53, N.Y., Irreg.

Ohio State University, Engineering Experiment Station, Bulletin, Columbus, Ohio, BM.

Ohio State University, Engineering Experiment Station, News, Columbus, Ohio, M.

Pacific Aeronautical Library, Check-List, 6715 Hollywood Blvd., Los Angeles 28, Calif., Irreg.

Photogrammetric Engineering, The American Society of Photogrammetry, P.O. Box 18, Benjamin Franklin Sta., Washington, D.C., $1.50 per issue.

Planes, Aeronautical Chamber of Commerce of America, Inc., 610 Shoreham Bldg., Washington 5, D.C., M.

Polish Engineering Review, Association of Polish Engineers in Canada, 3432 Drummond St., Montreal, Quebec, BM, $0.50, $3.00.

Press Summary, Society of British Aircraft Constructors, Ltd., 32, Saville Row, London, W.1, W.

Production Information, Automotive Council for War Production, New Center Bldg., Detroit 2, Mich., M.

The Propeller, Air Service Veterans' Assn., 7141 Jeffery Ave., Chicago 49, Ill., Q.

Quarterly of Applied Mathematics, Brown University, Providence 12, R.I., Q, $2.00, $6.00.

The Review of Scientific Instruments, American Institute of Physics, 57 E. 55th St., New York 22, N.Y., M, $0.50, $5.00.

Royal Aeronautical Society, Journal, 4, Hamilton Place, London, W.1, M, 7*s*. 6*d*., £4 10*s*.

Royal Meteorological Society, Quarterly Journal, 49, Cromwell Rd., London, S.W.7, Q, 7*s*. 6*d*. per issue.

SAE Journal, Society of Automotive Engineers, Inc., 29 W. 39th St., New York 18, N.Y., M, $1.00, $10.

Soaring, Soaring Society of America, Inc., Elmira, N.Y., BM, $4.00 yr.

Sociedad Cubana de Ciencias Físicas y Matemáticas, Revista, Habana, Cuba, Irreg., $0.50, $3.00 per vol. of 6 issues.

Spacewards, Combined British Astronautical Societies, 17, Southcote Ave., Tolworth, Surbiton, Surrey, Q.

Standards Review, British Standards Instn., 28 Victoria St., Westminster, London, S.W.1, Q, 2*s*., 7*s*.

The Thermal, The Southern California Soaring Assn., Inc., 453 S. Spring St., Los Angeles 13, Calif., M, $2.00 yr.

United States Naval Institute, Proceedings, Annapolis, Md., M, $0.50, $4.00.

Virginia Polytechnic Institute, Engineering Experiment Station, Bulletin, Blacksburg, Va., 16 issues per yr.

War Medicine, American Medical Assn., 535 N. Dearborn St., Chicago 10, Ill., M, $0.75, $6.00.

Warplane Production, Aircraft War Production Council, Inc., 7046 Hollywood Blvd., Los Angeles 28, Calif., BM.

Weekly Washington Bulletin, Aircraft Industries Assn. of America, Inc., Shoreham Bldg., Washington 5, D.C., W.

Weight Engineering, Society of Aeronautical Weight Engineers, Inc., 143 N. Brand Blvd., Glendale 3, Calif., Q, $0.50, $1.75.

The Welding Journal, 33 W. 39th St., New York 18, N.Y., M, $0.75, $5.00.

West Coast Air Mail Society, Bulletin, Ralph A. Freiburg, 4142 26th St., San Francisco 14, Calif., BM.

Wings Club, Inc., Bulletin, 50 Vanderbilt Ave., New York 17, N.Y., M.

Government Publications

Aerodrome Abstracts, compiled by the Department of Scientific and Industrial Research and issued in collaboration with the Air Ministry, The Institution of Civil Engineers, St. George St., Westminster, London, S.W.1, M.

Aeronáutica, Clasificador F-468, Santiago de Chile, M, $6.00 (pesos), $50 (pesos).

Air Force, U.S. Govt. Printing Office, Washington 25, D.C., M, $0.20, $2.00.

Air-Tact, Michigan Wing 63, Civil Air Patrol, 2310 Book Tower, Detroit, Mich., M.

Anahuac, Calle 21 Núm. 500 Col. Moctezuma, Mexico, D.F., $0.25 Mex., $3.00 Mex.

Army Life, Recruiting Publicity Bureau, U.S. Army, Governors Island, N.Y., M.

Australia, Council for Aeronautics, Reports, Box 4331, G.P.O., Melbourne, Irreg.

Belgium, Service Technique de l'Aéronautique, Bulletin, 72, Chaussée de Waterloo, Rhode-Saint-Genèse, Belgium, Irreg.

Bulletin of War Medicine, British Information Services, 30 Rockefeller Plaza, New York 20, N.Y., M, $0.40, $4.65.

CAP News Bulletin, Civil Air Patrol. Texas & Pacific Bldg., Fort Worth 2, Tex., W.

Civil Aeronautics Journal, U.S. Govt. Printing Office, Washington 25, D.C., M, $0.05, $0.50.

Contact, School of Aviation Medicine, U.S. Naval Air Station, Pensacola, Fla., Q.

The Department of State Bulletin, U.S. Govt. Printing Office, Washington 25, D.C., W, $0.10, $2.75.

Domestic Commerce, U.S. Govt. Printing Office, Washington 25, D. C., M, $0.10, $1.00.

Foreign Air News Digest, Air Transport Information Division, Economic Bureau, Civil Aeronautics Board, Washington 25, D.C., BW.

Foreign Commerce Weekly, U.S. Govt. Printing Office, Washington 25, D.C., W, $0.10, $4.50.

France, Direction des Industries Aéronautiques, Notes Techniques, Ed. Blondel la Rougery, 7, rue Saint-Lazare, Paris, Irreg.

France, Direction des Industries Aéronautiques, Publications Scientifiques et Techniques Ed. Blondel la Rougery, 7, rue Saint-Lazare, Paris, Irreg.

France, Secrétariat d'État à l'Aviation, Bulletin des Services Techniques, Ed. Blondel la Rougery, 7, rue Saint-Lazare, Paris, Irreg.

Gt. Brit., Aeronautical Research Committee, Reports and Memoranda, British Information Services, 30 Rockefeller Plaza, New York 20, N.Y., Irreg.

Gt. Brit., Air Ministry, Library, Additions List, The Librarian, Whitehall, London, S.W.1, M.

Gt. Brit., Air Registration Board, Notice to Licensed Aircraft Engineers and to Owners of Civil Aircraft, Brettenham House, Strand, London, W.C.2, Irreg.

Gt. Brit., Ministry of Aircraft Production, Abstracts from the Scientific and Technical Press, and Titles and References of Articles and Papers Selected from Publications (Reviewed by R.T.P. 3), Together with List of Selected Translations, The Royal Aeronautical Society, 4, Hamilton Place, London, W.1, M.

Gt. Brit., Ministry of Aircraft Production, Translations, The Secretary (R.T.P. 3), Millbank, London, S.W.1, M.

Gt. Brit., Stationery Office, Government Publications, British Information Services, 30 Rockefeller Plaza, New York 20, N.Y., M.

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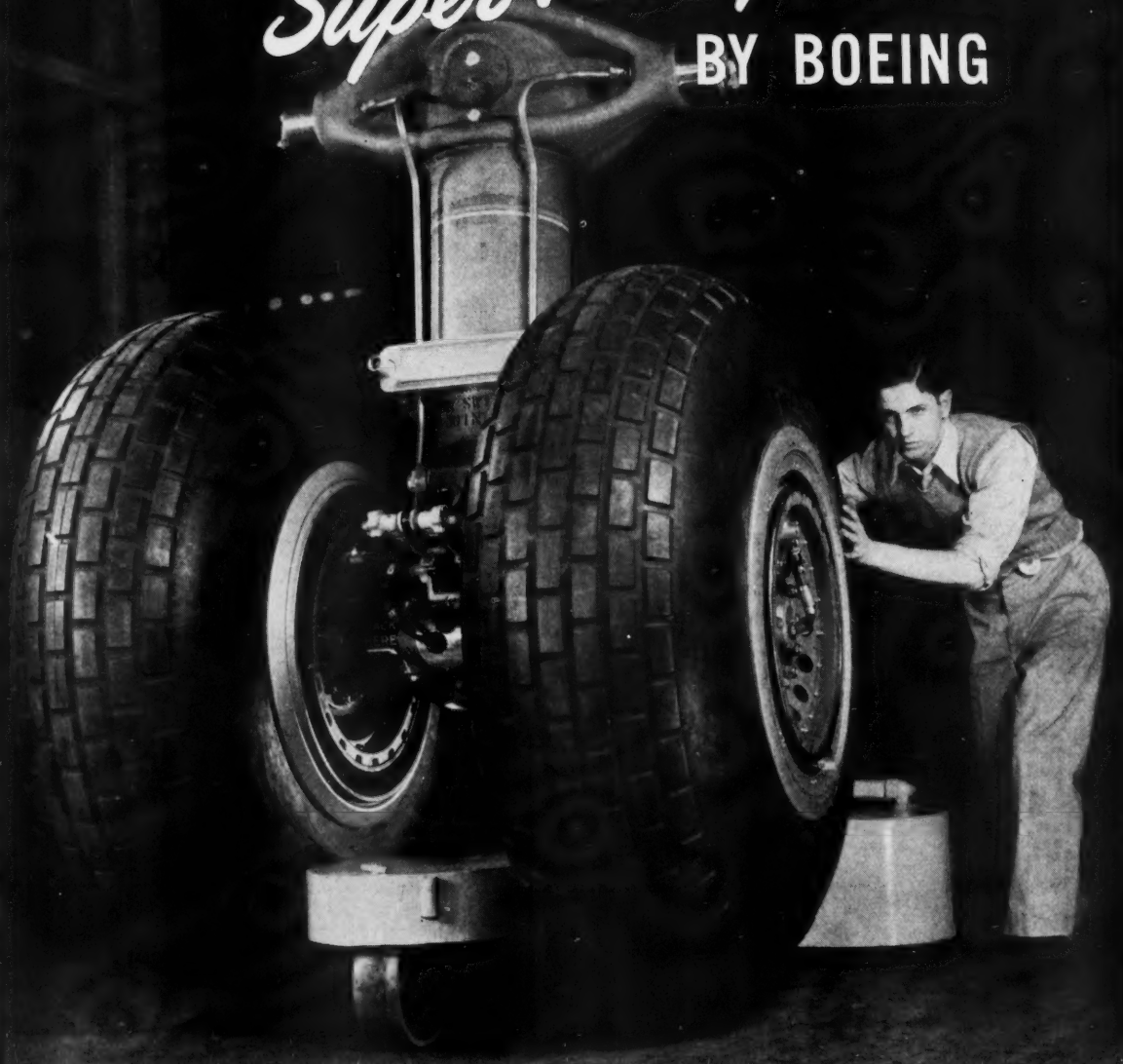

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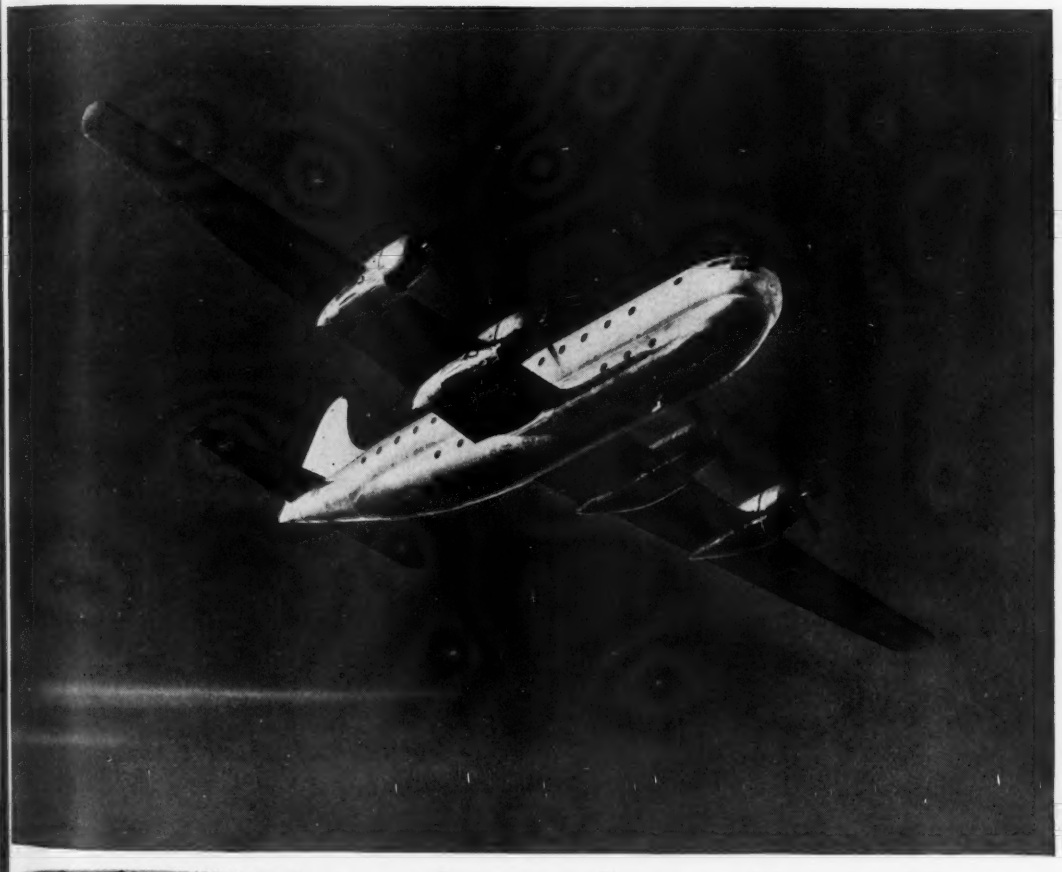

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The Skyliner, Transcontinental & Western Air, Inc., Kansas City, Mo., M.
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The Southernaire, Southern Airways, Inc., 400 Trust Co. of Georgia Bldg., Atlanta 3, Ga., M.
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Sperryscope, The Sperry Corp., Manhattan Bridge Plaza, Brooklyn 1, N.Y., Q.
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The Valve, Wilcox-Rich Div., Eaton Mfg. Co., Battle Creek, Mich., M.
The Volunteer, Consolidated Vultee Aircraft Corp., Nashville Div., Nashville, Tenn., W.
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The Air-Scoop, Army Air Base, Pueblo, Colo., W.
Alamogordo Blockbuster, Army Air Base, Alamogordo, N.M., W.
AM, Army Air Field, Lincoln, Neb., W.
Army Wives Informer, Officers' Mess, HQ. 4th Air Force, Hamilton Field, Calif., M.
Barksdale's Bark, Army Air Forces, Barksdale Field, La., W.
The Beach Post, Training Center No. 1, Army Air Forces, Miami Beach, Fla., W.
The Beam, Pilot School (Advanced Single Engine), Army Air Forces, Army Air Field, Marianna, Fla., W.
The Beam, Special Service Office, Army Air Forces, Bolling Field, D.C., SM.
Biggstuff, Army Air Forces, Biggs Field, Tex., W.
Black Landmarks, Blackland Army Air Field, Waco, Tex., W.
The Block Buster, Army Air Field, Gulfport, Kan., M.
The Bomb Bay, Army Air Forces, Hammer Field, Fresno, Calif., W, $2.00 yr.
Bomb Blast, Army Air Field, Childress, Tex., W.
Bombing Range High Score, Army Air Forces, Avon Park, Fla., W.
Bombs Away, Army Air Field, Victorville, Calif., SM.
The Bombsight, Advanced Flying School, Army Air Forces, Kirtland Field, N.M., W.
Booster, Pilot School (Advanced Single Engine), Army Air Forces, Napier Field, Dothan, Ala., W.
Boot Hill Marauder, Army Air Field, Dodge City, Kan., W.
The Bradley Beam, Army Air Forces, Bradley Field, Conn., W.
The Cactus, Army Air Field, Kingman, Ariz., W.
The Carrier, Army Air Forces, Bowman Field, Louisville, Ky., W.
Casual Observer, Army Air Field, Lemoore, Calif., W.
Command Post, Air Service Command, McClellan Field, Sacramento, Calif., W.
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The Dalhart Buzzer, Army Air Field, Dalhart, Tex., W.
Del Valle News, Bergstrom Army Air Field, Austin, Tex., W.
Drew Field Echoes, Army Air Base, Drew Field, Tampa, Fla., W.
The Eagle Eye, Eagle Pass Army Air Field, Eagle Pass, Tex., W.
Enid Plane Facts, Enid Army Flying School, Enid, Okla., W.
The Fighter Pilot, Army Air Field, Pocatello, Idaho, W.
Flexigun, Flexible Gunnery School, Army Air Forces, Ft. Myers, Fla., M.
The Flight Pattern, Army Air Field, Douglas, Ariz., SM.
Flight Time, Basic Pilot School, Army Air Forces, Goodfellow Field, Tex., W.
Flyer, Army Air Base, Reno, Nev., W.
The Flyer, Army Air Field, Chico, Calif., W.
Flying Time, Pilot School (Basic), Army Air Forces, Pecos, Tex., W.
Flying Time, South Plains Army Air Field, Lubbock, Tex., W.
The Ford Islander, U.S. Naval Air Station, Pearl Harbor, T.H., W.
Foster Field Fighter, Army Air Forces, Foster Field, Tex., M.
The Greenville Post, Army Air Field, Greenville, Miss., W.
The Greenwood Gremlin, Pilot School (Basic), Army Air Forces, Greenwood, Miss., W.
The Gunner's Post, Flexible Gunnery School, Army Air Forces, Harlingen, Tex., W.
Hamilton Field Takeoff, Army Air Forces, Hamilton Field, Calif., M.
Hawk's Cry, Army Air Field, Tuskegee, Ala., W.
Jefferson Barracks Hub, Air Forces Basic Training Center, Jefferson Barracks, Mo., W.
The Keesler Field News, Eastern Technical Training Command, Army Air Forces, Biloxi, Miss., W.
Lille Norge Avisen, Training Centre, Royal Norwegian Air Force, 341 Church St., Toronto, M.
The Lockbourne Air Base News, Lockbourne Army Air Base, Columbus, Ohio, W.
The Lukominique, Army Air Forces, Luke Field, Ariz., W.
The M.A.A.F. Cowling, Marana Army Air Field, Tucson, Ariz., SM.
The March Field Beacon, Army Air Forces, March Field, Calif., W.
Marfacts, Pilot School (Advanced Two Engine), Army Air Forces, Marfa, Tex., W.
NAAF News, Army Air Field, Newport, Ark., SM.
News, Army Air Field, Presque Isle, Me., W.
The Northern Dispatch, Army Air Base, Great Falls, Mont., W.
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The ORD News, Army Air Forces Training Command, Greensboro, N.C., W.
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Roger, 6th Ferrying Group, Air Transport Command, Army Air Field, Long Beach, Calif., W.
The Runway, Army Air Forces, Pope Field, Ft. Bragg, N.C., SM.
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The Salt Tablet, Army Air Base, Wendover Field, Utah, W.
Salvo, Army Air Base, Roswell, N.M., W.
Selfridge Field News, Army Air Forces, Selfridge Field, Ala., SM.
Shorelines, Redistribution Center, Army Air Forces, Santa Monica, Calif., W.
Skyscrapers, U.S. Naval Air Station, Floyd Bennett Field, Brooklyn, N.Y., W.
The Slip Stream, Army Air Base, Casper, Wyo., W.
SNAFU, Eastern Flying Training Command, Army Air Forces, George Field, Ill., W, $0.05 per issue.
Snaproll, Pilot School (Basic), Army Air Forces, Minter Field, Bakersfield, Calif., Irreg.
Snowball, 1380th AAF Base Unit, North Atlantic Division, Air Transport Command, Presque Isle, Me., W.
Sololand, Lodwick School of Aeronautics, Inc., Lakeland, Fla., SM.
Tac Tactical Center, Army Air Forces, Orlando, Fla., W.
Tail Skid, Army Air Forces, Lawson Field, Ga., W.
Tailspin, Army Air Forces, Ellington Field, Houston, Tex., W.
The Tail-Spinner, Army Air Forces Preflight School, San Antonio, Tex., W.
Take-Off, Farris Publishing Co., Tinker Field, Okla., W.
TARFU, Laughlin Army Air Field, Del Rio, Tex., W.
The Tarranter, Army Air Field, Ft. Worth, Tex., W.
Texacts, Army Air Forces Technical School, Sheppard Field, Tex., W.
Thunderbird, The Rapid City Journal, Rapid City, S.D., W.
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Upcheck, Lewis School of Aeronautics, Lockport, Ill., M, $3.00.
Vox Prop, Air Service Command, Army Air Field, Rome, N.Y., W.
Williams Field Airfax, Army Air Forces, Williams Field, Chandler, Ariz., W.
Wing Tips, Pilot School (Specialized Two Engine), Mather Field, Sacramento, Calif., W.
Wingspread, Army Air Forces, Peterson Field, Colorado Springs, Colo., W.
Wing-Tips, Waco Army Flying School, Waco, Tex., W.
Yuma Actioneer, Army Air Field, Yuma, Ariz., W.
Zoom, Basic Flying School, Army Air Forces, Bainbridge, Ga., W.

An Appreciation

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They enable the Institute to publish scientific and technical papers in the *Journal* and to devote its pages exclusively to editorial material.

Dues from individual members which would normally be used to publish this scientific and engineering quarterly are thus released for additional services to the profession and industry.

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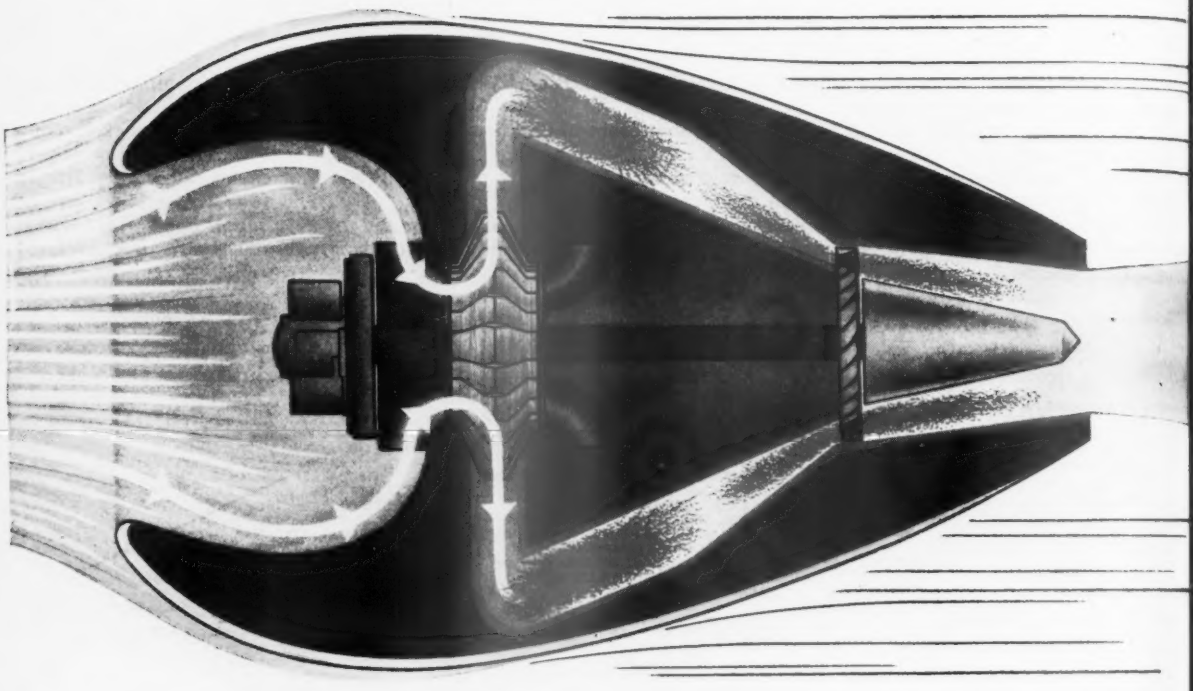
G.E. POWERS THE



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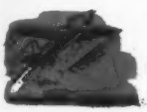

As the Army Air Forces' newly announced P-80 streaks through the skies, there flies with her the makings of an unprecedented era of aerial progress. For here is not only jet propulsion. Here, as a working reality, is the dream of thousands of engineers—a practical, efficient aircraft ***gas turbine***.

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House Organs and Catalogues

Twenty-Year Record of an Aircraft-Engine Company

Twentieth Anniversary Issue. The 20th anniversary of the Pratt & Whitney Aircraft Division of United Aircraft Corporation is commemorated in a special issue of this company magazine.

A series of articles relates how the Division was organized, how it developed, the aircraft engineering progress it sponsored, its contributions to the war effort, and the records that were established with its engines. Photographs are shown of personnel who started with the company 20 years ago and are "still on the job." There are also pictures of various airplanes powered by Pratt & Whitney engines. A complete index of warplanes powered by the company's engines is given, with the list divided into classifications of fighters; bombers; transport, cargo, and troop-carrier airplanes; trainers; observation and miscellaneous-purpose aircraft. *The Bee-Hive,* August, 1945.

Forging Techniques

Forgings by Wyman-Gordon. The equipment, facilities, procedures, and products of a forgings-manufacturing company are depicted in this 64-page book. The brief explanatory text also tells something about the organization, history, and personnel of the company. *Wyman-Gordon Company,* Worcester, Mass.

Training Aids for Aircraft Maintenance

Maintenance Training. A description is given of various training aids employed by Douglas Aircraft Company, Inc., to facilitate the instruction of maintenance personnel in the care and repair of Douglas airplanes. Six types of training aids are reviewed: the first, single-unit arrangements, includes individual mock-ups of the hydraulic and fuel systems; the second, double-unit arrangements, shows combinations of flight controls and autopilot and of instruments and electrical devices; a typical triple-unit combination is a demonstration mock-up of the hydraulic, fuel, and oil systems. Schematic mock-ups; service-school mock-ups; and such instructional mediums as wall charts, microfilm, and service manuals comprise the other three types of functional training aids. *Douglas Aircraft Company, Inc.*

Miles Aircraft Types

Milestones. A record of Miles-manufactured aircraft is contained in this booklet, which gives illustrations, brief descriptions, and outline histories of the successive types. Beginning with the Gnat, Martlet, Metal Martlet, Satyr, Hawk, and Hawk Major, the evolution of the Miles aircraft is traced through the Hawk Speed Six, Falcon Major, Falcon Six, Merlin, Sparrowhawk, Hawcon, Nighthawk, Peregrine, Kestrel, and Master I. Whitney Straight, Mohawk, Hobby, Magister, T.1/37, Mentor, Monarch, X.2 Project, M.18, and Master II are then considered. The planes reviewed in the final series are the Master Glider Tug, M.20 Fighter, M.21 Project, M.22 Project, M.23 Project, Master Fighter, and Martinet. *Miles Aircraft Limited,* Reading, England, 2*s*.

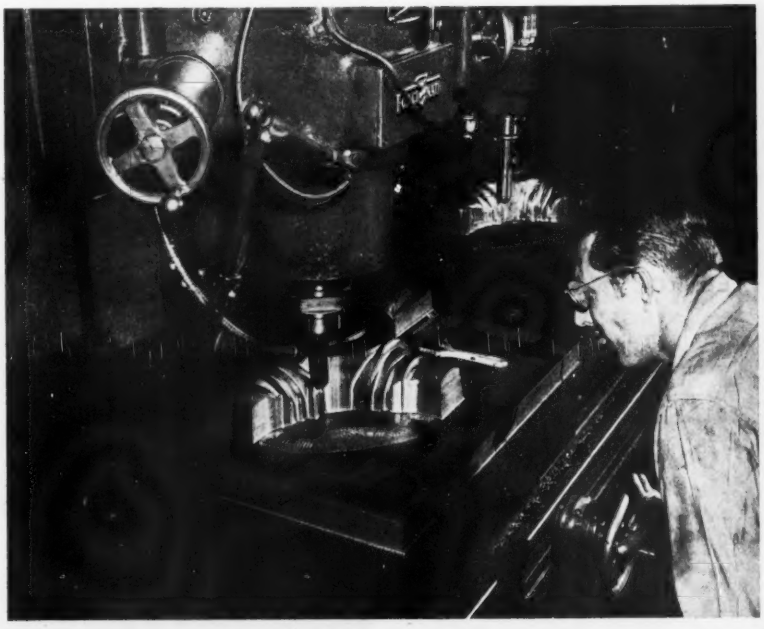
Maintenance, Repair, and Use of Parachutes

Parachute Riggers Bulletins. Part of a technical data series for licensed riggers, this group of bulletins includes *Nos. 36–45, 47,* and *48.*

Illustrated by drawings, *Bulletin No. 36* contains general instructions for packing Switlik parachutes. *No. 37* describes the proper method of installing a new suspension line on a parachute. *No. 38* outlines correct procedures for cleaning parachute canopies. In *No. 39* directions are given for the storage of parachutes. The sixteen parts of *Bulletin No. 40* are composed of excerpts from Civil Air Regulations pertaining to parachutes. *No. 41* deals with the standardization of Q.A. seat and Q.A. back harness and risers, *No. 42* advises how to prevent mildewing of parachutes, and *No. 43* tells how to use the snap-type line retainers. *Bulletins Nos. 44 and 45* give information relative to the interchangeability of Switlik parts and to major repairs of the parachutes. *Bulletins Nos. 47 and 48* contain specific catalog numbers for various components of parachutes to facilitate ordering and to avoid the possibility of error. *Switlik Parachute Company,* Trenton, N.J.

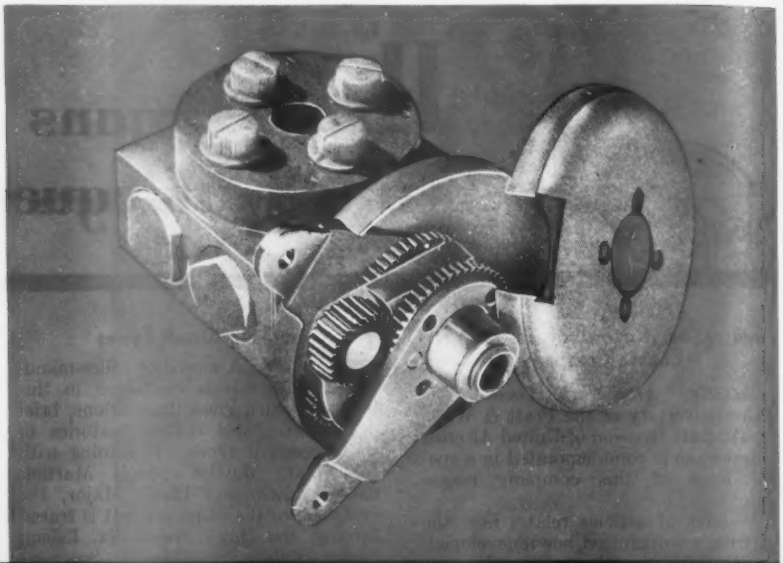
Obtaining a Private Pilot's Certificate

Make the Skyways Your Highways. A booklet of 19 pages is designed to spur interest in private flying by showing that air travel is already within the reach of virtually every American. By illustrating basic flying maneuvers and



Finished die for a four-bladed propeller barrel forging being duplicated from a master and nearing completion at the Wyman-Gordon Company.

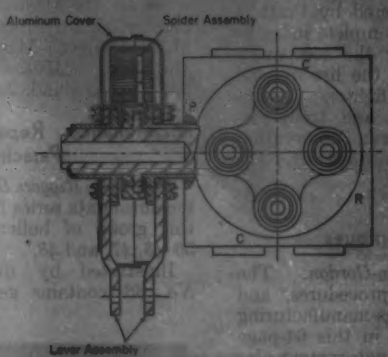
precise control



ELECTROL'S Follow-up Selector Valve

This unique follow-up selector valve opens new possibilities in aircraft control. Compact and simplified in design, the mechanism allows the pilot precise, finger-tip control for exact duplication of angular movement or proportional movement of remote control surfaces. For example, the unit is now in successful operation on wing-flap control in hard-hitting Navy bombers. Postwar cargo and transport can utilize this versatile valve in numerous servo applications.

Simplicity in construction assures trouble-free, positive operation—adjustable to within one-fifth of one degree. Weight is a minimum, and first cost is low. The ELECTROL follow-up valve, like other ELECTROL units—check valves, relief valves, unloader valves, selector valves, cylinders and handpumps—can be adapted to your aircraft design. Check with ELECTROL engineers before you plan your control system.



Two planetary gears are mounted on a spider fixed to the valve operating shaft. These gears are in mesh, and each meshes with a sector gear, free to rotate on the shaft. One sector gear is connected to the control lever; the other to the mechanism being controlled. Clockwise movement of the control sector causes opposite rotation of the planetary pinion in mesh with the second planetary gear, resulting in a counter-clockwise movement of the spider. This rotation opens the four-way valve permitting fluid flow to motor or cylinder. Since the unit being controlled is mechanically connected to the second sector gear, which also meshes with the planetary gear on the spider, movement of the controlled element tends to rotate the spider clockwise so that the valve is returned to neutral, thus locking the controlled element in the pre-determined position.

ELECTROL INCORPORATED
KINGSTON, N. Y.

ELECTROL
HYDRAULICS

showing some of the products that the airplane dealer can supply, it is intended to stimulate the desire to become a private pilot.

The themes propounded are that flying is fun, is healthful, and is a means of getting to one's destination quickly and that civilians should "get in at the start." Common questions asked by flying enthusiasts and novice fliers are answered in simple language, showing that learning to fly is easy, quick, safe, and inexpensive. *The Firestone Tire & Rubber Company.*

Hydraulic Control Equipment

ISOdraulic Control, Type A is described in a catalog of 16 pages. Information is given about the design and construction of the master unit, the operating unit, and the equalizer, together with drawings, performance charts, and tables of dimensions.

A separate booklet gives service instructions for the Type A ISOdraulic control, especially for installing and maintaining the equipment. *Adel Precision Products Corporation,* Burbank, Calif.

Radio Control-Panel Data

Bulletin SE-115 contains instructions for the installation and operation of the MS-106A control panel for converted C-54 (Beech 18) airplanes. It gives general specifications of the control panel and details concerning component parts of the unit.

Bulletin SE-116 contains similar information with respect to the MS-90 and MS-91 series control units for Douglas DC-3 aircraft.

MT-93 Expressor Amplifier gives specifications of the radio unit designated. The apparatus was designed to solve the problem of operating communication equipment from a control point where noise prevails. It is described as a single compact unit that is constructed to reduce practically any amount of background noise, as well as maintain a constant output level regardless of change in volume of the speaker's voice in the microphones. *Bendix Radio Division, Bendix Aviation Corporation.*

Aero Research Technical Notes

Aerolite Foam Glue for Plywood and Veneering is the title of a bulletin about foam glue used as an adhesive where cost reduction is important. It describes the foam machine and gives instructions for making the foam and for applying the method.

Mechanical Joints are described in a bulletin that contains information about bolts, nails, and dowels as devices for holding wooden parts together. The advantages and disadvantages of each type of fastening are reviewed, and recommendations are made for the proper use of these types of connections. *Bulletin No. 31,* July, 1945; *Bulletin No. 32,* August, 1945; *Director of Research and Development, Aero Research Limited,* Duxford, Cambridge, England.

Die-Casting Machines

Die Cast Your Product is an illustrated catalog of 22 pages describing a new series of machines for pressure die casting. It gives the operation and production features of the different series of these machines, together with specifications and dimensions. Accessories used with the machines are combined and offered by the manufacturer as a "packaged" unit. *H. L. Harvill Manufacturing Company,* Vernon, Calif.

Reconversion Suggestions

Planning for Reconversion is a booklet illustrated in color suggesting peacetime applications for the facilities of manufacturing plants formerly engaged in war production. It outlines the different equipment and the skills of personnel now made available to industry to aid in a rapid return to the production of goods for civilian use. Among the products featured are cartridge-type aircraft-engine starters, light bullet-proof steel, lightweight flexible conduit, radio ignition shielding, electric equipment, and other products. The manufacturer's research and development organizations are noted. *Breeze Corporations, Inc.,* Newark, N.J.

Pneumatic Equipment

Versatile Controlled-Air Power is a new bulletin containing information about the application of pneumatic power in industrial operations. Details are given about the manufacturer's air motors and accessories, with tabulated specifications, dimensions, and suggestions for use. *The Bellows Company,* Akron, Ohio.

Callinite Alloys

Bulletin No. 58 reviews a group of alloys made by the Callinite powder metallurgic process. Callinite is reported to be a high-conductivity facing material for applications requiring high currents where pitting, sticking, or welding of contacts may occur. It is also recommended by the maker for facing arcing tips on air circuit breakers, heavy-duty circuit breakers, motor controllers, heavy-duty relays, and industrial control contacts.

Various types of Callinite described in the bulletin include Type TC, a tungsten copper alloy, and Type ST, a tungsten silver alloy. Each of these types is available in three grades for specific applications. Callinite alloys are available in rods, squares, rectangles, and inserts. *Callite Tungsten Corporation,* Union City, N.J.

Tool Catalog

Pratt & Whitney Precision Machine Tools, Small Tools, Gages. A condensed list of products made by Pratt & Whitney is described and illustrated in this catalog. It is divided into four parts: the first dealing with machine tools, the second with small tools, and the third with gages. The final section shows the equipment manufactured by other tool concerns and offered by Pratt & Whitney as sales representatives. *Pratt & Whitney Division, Niles-Bement-Pond Company,* West Hartford, Conn.

Revised Sections of C.A.R.

Here's How. This is a compilation of the revised sections of the Civil Air Regulations which became effective July 1, 1945. It includes air traffic rules, regulations with regard to pilot certificates, and general operations rules. The reprint of the revisions is preceded by advice to military and naval pilots cautioning them on the care that is necessary during the transition from military to civil flying. *Aero Insurance Underwriters,* New York.

Latin America

The Wealth of the Other Americas. Data on trade and industrial activity in the Latin American countries are supplemented by maps and descriptive details about each country and its people. While the booklet also includes general information regarding the transportation facilities in the various countries, climates, what to wear when visiting different regions, etc., it stresses the air-transportation services operated by Pan American to South and Central American countries. Individual chapters of the book are devoted to Mexico; Cuba; Central America; Colombia; Venezuela; Brazil; Ecuador; Peru; Bolivia, Paraguay, and Uruguay; Chile; Argentina; and the West Indies. *Pan American World Airways.*

Fuel-Pump Equipment

Bulletin No. 9 contains data about the Pesco fuel booster pump for aircraft. In addition to a description of the construction and operation of the unit, specifications are tabulated and performance curves give figures to show the results that can be expected from the equipment. Installation drawings show outlines and dimensions. *Pesco Products Company Division, Borg-Warner Corporation,* Cleveland.

X-Ray Apparatus

Engineering-Design Development of X-Ray Spectrometer, by J. S. Buhler, originally appearing in the magazine *Electrical Manufacturing,* has been reprinted in the form of a 12-page booklet. It deals with the basic design principles involved in the Geiger-Counter X-Ray Spectrometer. The writer gives specific information about X-ray diffraction principles, new instrument requirements, X-ray source, pulse conditioning, the frequency-meter circuit, the counting meter circuit, controls, and applications. *North American Philips Company, Inc.,* New York.

Tubing Inspection

How to Spot and Stop Defects deals with the inspection of metal tubing. Inspection methods are reviewed, and specific details are given about the different types of defects which result in rejection and failure of tubing for industrial use.

A 4-page leaflet gives specifications and other information about the different types of seamless steel tubing, including aircraft tubing. *Michigan Seamless Tube Company*, South Lyon, Mich.

Industrial Incentives

The Beech Efficiency Incentive Plan reviews the operation and results of the industrial-incentive experience of the Beech Aircraft Corporation from the inception of the plan in December, 1941. A section gives the record of results illustrated by charts showing monthly output in pounds of aircraft and per dollar. Other sections contain comments and suggestions. *Beech Aircraft Corporation.*

Gear Catalog

Aircraft Quality Gears is the title of Product Engineering Bulletin AQA. It traces the development of what is designated as "Aircraft Quality" gears, created to meet the standards required for aircraft engines. Statistics are given about the precision manufacture and wearing qualities of these gears, with charts showing comparisons of their performance under varying conditions. The processes of manufacturing these gears are detailed, and numerous tables give comparative data. Different types of aircraft gears are used as examples of the gears supplied for aircraft use. Additional text matter and charts show how gear performance is calculated. Illustrations and descriptions of the application of gears in industries other than the aircraft industry are also included. *Foote Bros. Gear and Machine Corporation*, Chicago.

Modified Resistance Welding

Projection Welding describes a modification of the resistance-welding method defined as "a method of resistance welding by which the current flow and heating during welding are localized at a predetermined point by the design of the parts being welded." It is so named because the process is usually accomplished by the use of a projection or embossment on one or both of the pieces of work. The nature and development of the process are traced, and a detailed description is given of projection design. Other sections of the booklet deal with the machines, controls, jigs, and fixtures used and the materials and finishes for which the process is suitable. *The Ohio Nut & Bolt Company*, Berea, Ohio.

Metal-Cutting Equipment

Queen of the Battle Forces of Production is the title of an illustrated booklet that gives details of hand-operated and machine-operated cutting apparatus and tips for cutting metals. It gives specifications and details about the construction and use of tools and equipment for this purpose and is illustrated by photographs showing applications of metal-cutting by the use of gas flames. *Victor Equipment Company*, San Francisco.

Stripping Metal from Dies

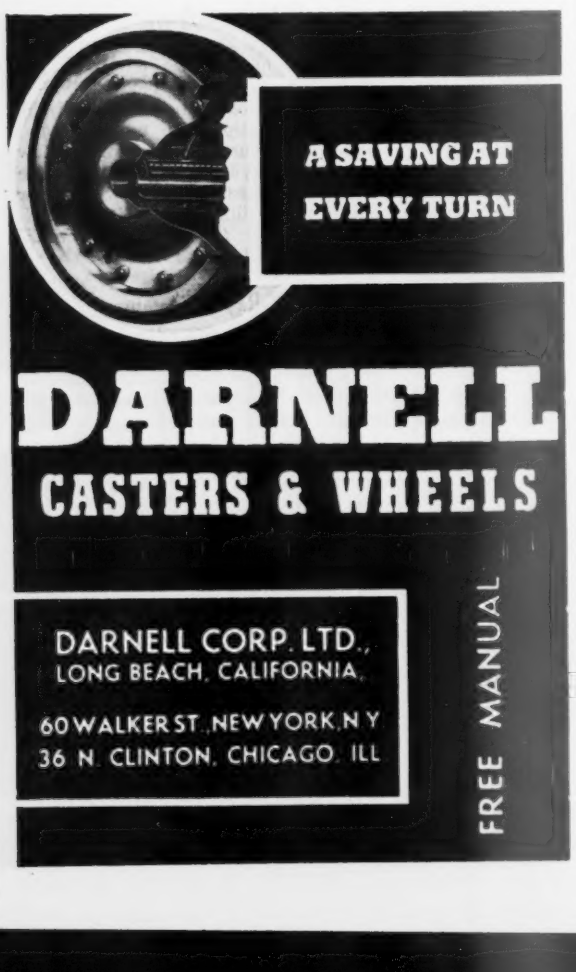
Catalog S. The second edition of this catalog is concerned with the features of spring stripping units—the design, construction, application, and advantages. Used for stripping metal from conventional dies, the units are self-contained and eliminate the necessity for removing dies from presses or disassembling to repair or replace defective parts. *Wales-Strippit Corporation*, North Tonawanda, N.Y.

Flight Courses

Here's Your Package of Flying. Each of the six "packages" outlined is a course in aviation training. Details are given as to what the course consists of, how much it costs, how long it takes, etc. The described schedules include ground school, flight, and instrument instruction leading to private, commercial, and instrument pilot ratings. *Wiggins Airways, Inc.*

New Magnesium Periodical

Magnewsium. The first issue of a new periodical for the magnesium industry appears in the form of several mimeographed sheets. Its introductory paragraphs announce that the periodical will be circulated among members of the Magnesium Association and that its purpose will be to disseminate systematically information about magnesium and its products. Volume 1, No. 1 includes, among other items, news about the dis-



FOR SALE

Manufacturing Rights For an Aircraft Engine

A large number of these light aircraft engines are in the field, giving an immediate market for overhauls and spare parts. Sale will include all available tooling and an inventory of parts. Engines carry full CAA approved type certificate.

This is an unusual opportunity to enter the light aircraft engine field or for a present manufacturer to expand. Inquiries are invited from responsible concerns. The entire rights will be offered at a very attractive price.

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Aeronautical Engineering Review

tribution of magnesium ingot to universities by the Defense Plant Corporation and the increased use of magnesium during the month of March, 1945. *The Magnesium Association*, New York.

Increased Air Traffic

The Coming Boom in Air Transport. W. C. Wold. Considering factors that will contribute to lower air-transport rates and increased use of this means of conveyance, this study deals separately with passenger traffic and air cargo. Factors of increased familiarity with air travel (attributable mainly to war experience), greater size of aircraft, increased speed, and lower costs are evaluated, with reasons given why larger and faster airplanes will tend to reduce the cost of traveling by air and result in an expanded volume of air traffic. In the analysis of future air cargo, three main categories of service are examined: the normal common carrier (including air mail, air express, and air freight), the contract carrier, and ownership of fleets of airplanes by business organizations whose size can make it profitable. *Plane Talk*, August, 1945.

Gas-Welding Repairs for Magnesium Components

Technical Memorandum No. 10 contains instructions for the repair of magnesium parts by gas welding. Particulars are given with regard to the materials and equipment to be used, field repair of magnesium castings, welding of castings to wrought parts, field repair of wrought magnesium, and cleaning and painting. *The Dow Chemical Company*, Midland, Mich.

Flexible Shaft Machines

Catalog No. 44. Information relative to a line of flexible shafts, flexible-shaft machines, and other power tools is cataloged in a 28-page directory. Specifications and prices supplement the descriptive text and illustration of each product. *Wyzenbeek & Staff, Inc.*, Chicago.

Extending Machinery Utility

Modern Motor-Generator Maintenance and Repair Equipment for Reconditioning War Weary Machinery. A line of equipment for reconditioning, repairing, and maintaining motors and generators is described in this catalog. Among the devices whose features are surveyed are resurfacers, commutator-cleaning stones, grinders, undercutters, coil-winding equipment, portable industrial blowers and cleaners, electric soldering tools, and wire strippers. *Ideal Commutator Dresser Company*, Sycamore, Ill.

Spark-Plug Bushings

"Heli-Coil" Spark Plug Bushings. Designated as *Bulletin No. 237-A*, this 8-page leaflet demonstrates the advantages of "Heli-Coil" spark-plug bushings as opposed to various other types of installations. The leaflet contains data on the design, assembly, and servicing of these bushings. In addition, a typical installation is described. *Aircraft Screw Products Company, Inc.*, Long Island City, N.Y.

Additions to Plywood Handbook

Douglas Fir Plywood Data. Two additional sections are ready for the handbook, *Technical Data on Plywood.* Section 9, "The Design of Built-up Beams with Plywood Webs," is new material. It outlines a rational method of designing plywood beams to withstand given loads with adequate safety factors. Section 1A Revised supersedes the present Section 1A. Representing the latest revision of the U.S. Commercial Standard for Douglas fir plywood, the new Section 1A became effective on January 27, 1945. It differs from the previous standard principally in these items: a marine grade has been added to the exterior type; a 10-cycle performance test, used for many years by the Association's Inspection Department, has been included; the door-panel grade has been revised to conform to door manufacturers' standards; and reinspection regulations have been modified to give added protection to the consumer. *Douglas Fir Plywood Association*, Tacoma, Wash.

Catalog on Electronic Tubes

Electronic Tubes. Various types of electronic tubes are listed in this manual. It is published in loose-leaf form to permit revised data to be added. Tabbed dividers are provided for each section to aid readers in referring to the desired class of tubes. General and technical data are supplied for each of eight types of tubes, as well as vacuum gages and vacuum switches. *General Electric Company.*

Rules of Conduct

Mosquito Mutterings. A collection of cartoons emphasizes basic rules of conduct and procedure for air and ground personnel. The booklet is divided into two parts: the first deals with "do's and don't's" for air-crew members; the second, with "do's and don't's" for ground-crew members. *The de Havilland Aircraft of Canada, Ltd.*

Suggestions for Peacetime Activities

Are You Ready for Tomorrow? A special study of the facilities of an engineering organization available for peacetime work. It suggests new materials, devices, equipment, and methods to aid manufacturers in their problems of reconversion.

Among the materials featured are plywood, light metals, and plastics, while new devices in electronics, aviation, rockets, lighting, heating, and ventilation are visualized as subjects to which future planning should be given. Other sections contain suggestions for the development of business and new methods, as well as the provision of facilities for the comfort of customers and employees. *Service Engineering, Kent-Moore Organization, Inc.*, Detroit.

Multiple Air Travel Plan

The Volume Air Travel Plan. An illustrated leaflet explains the Universal Air Travel Plan and how it operates. This is a system of travel identification to facilitate air travel on a charge-account basis. Economies derived from this "air travel cards" plan are indicated. The booklet also contains information about reductions in air fares which have been effected between the years 1942 to 1945. *United Air Lines, Inc.*

Pressure Connectors for Aluminum Cable

Aluminum Cable Connectors. A line of aluminum pressure connectors and installing tools for aluminum cables is described in a bulletin, *No. 27.* Technical and installation data are given for straight and angle aluminum lugs; designs are suggested for postwar requirements; and the basic hexagonal feature of the device is explained. Several pages of the bulletin are devoted to a report of laboratory testing results, and photographs of standard and custom-made installations illustrate the applications of the aluminum connectors. *The Thomas & Betts Company*, Elizabeth, N.J.

Gyropilot and Power Supplies

A-3 Gyropilot. Descriptive data and specifications relative to the A-3 Gyropilot, a vacuum pump, a Vickers piston-type oil pump, a vacuum relief valve, and a central air filter are contained in *Publication 15-39.* Details of the Gyropilot's control units and accessories are reviewed and illustrated. Catalog numbers for the various parts of the Gyropilot are listed, drawings of all equipment are shown, and the locations of the Company's service stations are given. *Sperry Gyroscope Company, Inc.*

Aerodynamic Fundamentals

Even I Can Understand! Written for the layman, this booklet interprets in simple terms some of the fundamentals of aerodynamics. In question-and-answer form, it explains longitudinal stability; why there is a trend toward increasing the number of blades on propellers; compressibility; exhaust and wing-tip trails; the consideration of feathering propellers as a necessity on multiengined aircraft; lateral stability; advantages of propeller counterrotation; the nature of induced drag and parasite drag; and possible limitations to the size of aircraft. Answers are also given to questions of why an airplane needs more power to fly at the same indicated air speed at a greater height; how an airplane is propelled; how tension and compression are dealt with in an airplane structure; how bending is dealt with; what factors govern the choice of materials used in aircraft construction; and what the principles of supercharging are. Other information pertains to the principal features of jet propulsion; how lift is obtained from a moving airfoil; how the energy con-

THIS HIGHLY TRAINED NAVIGATOR has picked many a precision course through thousands of miles of naked Pacific sky. For more than 3 long years his tools have been the sun and the stars, maps and almanacs, charts and calculators, his aircraft instruments and his precious octant; *but all of them useless without his accurate skill.*

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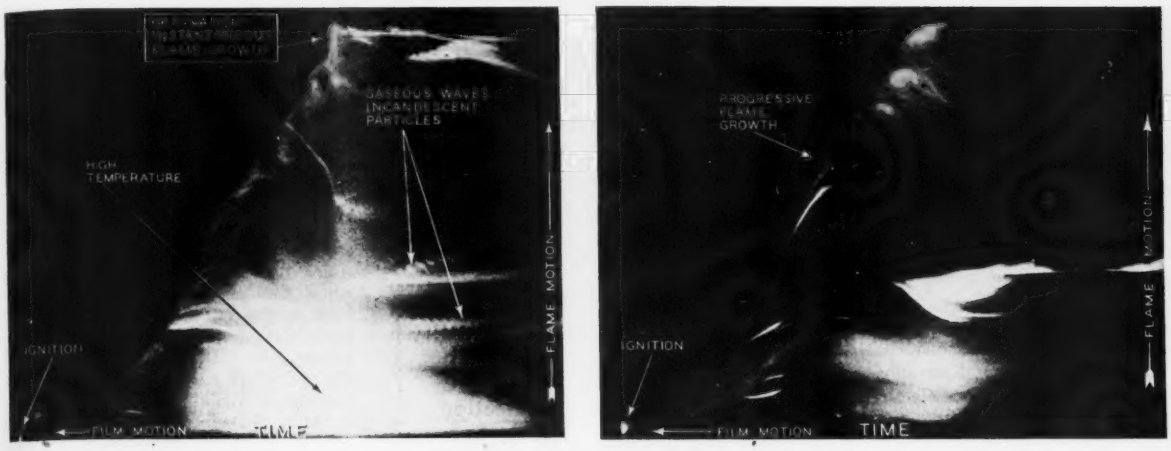
KEEPING AIRCRAFT INSTRUMENTS *operating satisfactorily, regardless of temperature conditions or humidity, is the job of Esso Aviation Instrument Oil, one of the first instrument oils with rust-inhibiting qualities approved under Army-Navy Specification AN-O-4. Esso Aviation Instrument Oil is also used in the speed-reducer gears of Curtiss Electric Propellers, and is ideal for high-speed light bearings . . . On the Sperry Gyro Compass (23,000 r.p.m.) the flux valve operates in a bath of Univis J-43 and the rotor bearings are lubricated with Teresso 43 . . . Still more proof that "You can depend on Esso Aviation Products."*



Photographs of engine combustions showing detonation, *left*, and normal growth of flame, *right*. These photographs were taken during tests made with the MIT-Sperry detonation indicator.

tained in the fuel is utilized by aircraft; why an engine converts less than a third of the fuel energy into useful work; and the nature of boundary layers. *The de Havilland Aircraft of Canada, Ltd.*

Future Aerodynamic Development

The Planes of Tomorrow. I. M. Laddon. The Executive Vice-President of Consolidated Vultee Aircraft Corporation offers some observations on future trends of development in aircraft design and construction. Explaining that function and economy will now be the two primary factors in airplane development, he considers some of the major engineering problems that have to be solved in order to increase the utility of the airplane. Among the phases of design development that he discusses are flying wings, design for flight at sonic and supersonic speeds, and gas turbines. *Plane Talk*, August, 1945.

Toggle Clamp

The New Mech-Master Toggle Clamp. A 4-page bulletin describes the new Mech-Master toggle clamp. It shows the possible applications of the clamp to jig and fixture work, as well as to various kinds of repair and bench operations. *The Mechanics Engineering Company*, Jackson, Mich.

Light-Plane Models

Aeronca: The Plane You'll Want to Fly. With illustrations and tables of specifications supplementing the descriptive data, the advantages of several Aeronca airplane types are extolled. The models described are the Champion, a two-place tandem-type airplane; the Chief, a two-place, "deluxe" type; the Chum, a two-control, "spinproof," low-wing airplane; the Arrow, a two-place low-wing model; and the Eagle, a four-place airplane. *Aeronca Aircraft Corporation.*

Airplanes Rented on Monthly Basis

Beechcraft Customer Service. This booklet tells of an airplane rental service that is now available. According to the plan, twin-engined four-or-five place Cessna aircraft can be rented on a monthly basis. Pilot services are provided, together with factory maintenance and repair of the airplane. Rental costs and incidental charges are given, specifications of the aircraft used are listed, and advantages of the plan to the customer are indicated. A copy of the agreement covering this rental service is included with the descriptive booklet. *Beech Aircraft Corporation.*

Equipment for Detecting and Evaluating Engine Detonation

M.I.T.-Sperry Detonation Indicator. Publication 23-82 explains the operating principles of a detonation indicator for aircraft engines having not more than 18 cylinders and describes in detail the construction and design of the indicator's component parts. Specifications and outline drawings of the equipment are included. A group of tables contains advice and ordering information about the particular devices. *Sperry Gyroscope Company, Inc.*

Extruded Products

Bulletin 64A contains information about a line of extruded rounds and shapes, rolled metal sheet, hollow bars, and swaged rods. Specifications and descriptive data are given relative to the products, and the standard terms of their sale are outlined. Prices are included. *Ampco Metal, Inc.*, Milwaukee

Production and Maintenance Suggestions

Douglas Airview, July, 1945. (1) Stand pipe for filler neck of wing tanks keeps out dirt, insures against wing collapse in case of plugged vents in the tanks, and saves money; (2) the use of two sizes of cuts instead of two profiled cuts in one phase of milling-machine operations saves time; (3) a router guide eliminates hand filing of holes in top and bottom panels of doors covering wing-attachment bolts, saving man-hours; (4) profile template saves setup time on milling operations of small parts; (5) use of plaster to replace metal templates for master patterns saves tooling time; (6) a jig for checking steel tubes formed on powder beader saves time; (7) plastic coating on plaster patterns during outside storage obviates the need for repair or replacement of patterns; (8) removal of graphite with solvent immediately after magnesium seat panels are formed saves cleaning time and produces cleaner parts; (9) the addition of plugs between waffle pins when pressure is applied to PBT backing plates prevents warping and breaking and saves rework time.

Eastern Aircraftsman, July, 1945. (1) Special nesting fixture for spot-welding reinforcement strips to the accessory cowl panel eliminates use of Yates clamps, besides saving production time and labor; (2) use of a set of templates for locating fuel line and attaching clamps in stub wing assembly eliminates rework; (3) use of a brake press instead of a hydraulic press speeds process of forming wing trailing-edge channel.

Republic Aviation News, June 29, 1945. (1) Apparatus for calibrating fuel-tank liquidometer saves time and labor; (2) tool aid in the heat straightening of turbo rings removes any twists in the rings resulting from rolling operations.

The Consolidated Vultee Eagle, June 29, 1945. (1) Special clamps for sawing scribed parts eliminates a large number of saw fixtures; (2) new method of forming plastic dies prevents plastic material from filling in the sides between the core and the form; (3) mechanical device for setting blades of propellers eliminates hand operation.

Douglas Oklahoma City Airview News, July 28, 1945. Metal boom jig to align the trailing edge bulkhead ribs before they are joined to the mid-rear section permits ribs to be pulled into position by means of a handle.

Flagship World, July-August, 1945. (1) Jig for use in installing steel bottoms on battery cases; (2) system for saving tray changes of spark plugs during engine overhaul; (3) tool for removing steel safety wires from engine cylinders; (4) attachment that permits stack drilling of several pieces at one time.

North American Take-Off, August 10, 1945. Use of four contour templates for checking lower longerons saves considerable handling time.

The Common-Ader, August 2, 1945. (1) All-position welding jig for tow-gear lugs on plane's nose section enables panel to be turned so that all sections may be welded freely; (2) permanent set gage to locate the position of skins and the dimension of cut on ribs for placing the skin eliminates spoilage by determining accurately the lap of the skins.

The Consolidated Vultee Eagle, August 10, 1945. (1) Use of Toolite plastic to glue plastic form blocks together eliminates hole-boring and use of bolts; (2) combination locating and welding jig for throttle and mixture-control brackets; (3) installation of fairleads in engine-control brackets reduces friction on control system.

North Ameri-Kansan, August 10, 1945. Special arbors or holders for valve-grinding machines enable perfect alignment and grinding of check jaws to be accomplished in considerably less time than previously required.

Important Announcement

The Officers and Council of the Institute of the Aeronautical Sciences are pleased to announce that the *Journal of the Aeronautical Sciences* will resume publication as a monthly starting in January, 1946. This change has been made possible because of the relaxation of restrictions controlling the use of paper. There will be no change in subscription rates.

Douglas Tulsa Airview News, August 3, 1945. (1) Adjustable joggle die for hat sections on power brake saves time and money; (2) tool for aligning and pressing bushings in rear bow fitting.

The Northrop News, August 1, 1945. (1) Improved Heliarc welding torch can be used in formerly inaccessible places, allows greater safety by cutting the flow of electricity and saves helium gas; (2) a device for slotting curved tubing, an incline attachment permitting proper tangent of abrasive cutting wheel to material, a roller guide preventing the radiac blade from bending, and a swivel stop for cutting angles on tubing have increased the versatility of the radiac saw, improved the quality of the saw, and facilitated operations; (3) a deicer boot stretching wrench, designed with a pin that fits in the Riv-Nuts, eliminates the possibility of the tool slipping and enables one man to perform the complete installation.

Boeing Plane Talk, August 18, 1945. (1) Suggestion to trim leading-edge attaching fairings of inboard nacelles without trial fittings saves man-hours; (2) cutting paper insulation to fit exactly the wire cavity before rewinding small motor armatures saves time; (3) tilting gage holder for use when submersing magnesium parts for dichromate treatment; (4) copper clamp-type terminals for use on auxiliary bus bars for chrome plating tank; (5) air-operated switch replaces microswitch mechanism on the Magnaflux machine.

AUTOFLIGHT "CONTROLLED-ACTION" BELLOWS
Autoflight Controlled Action Bellows derive their uniform and stabilized characteristics from careful control of the cold working or mechanical deformation of their material in manufacture.
Assembled from matched diaphragms, brazed gas and liquid tight, and provided with swaged sealing rings for maximum mechanical strength, operating strain in Autoflight Controlled Action Bellows is remarkably well distributed. Precise calibration is assured with linear movement for equal increments of pressure over the entire working range with zero hysterisis.
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During this critical shortage of tin, which now is even greater than in previous years of the war, Federated low-tin and tin-free solders are doing yeoman service in meeting today's soldering requirements.

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"S.T." SOLDERS are available in all commercial forms, including acid and rosin core wire. For details on the complete range and properties of these solders, or for technical assistance on a specific problem, contact our nearest office.

Martin Mars

Grumman Hellcat

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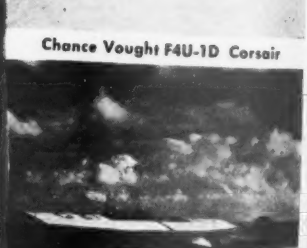
Where the Going is Toughest
...IT'S "PITTSBURGH"

EVERYTHING about a sky fighter, bomber or troop transport must be "tough as nails" to take the terrific punishment of wartime service. That goes for the protective finishes used inside and out—and that's why you'll find Pittsburgh's famous *"Fighting finishes"* on so many of Uncle Sam's victorious warriors of the sky. Pittsburgh Aircraft Finishes are unsurpassed for rugged, dependable, long-lasting protection. Where the going is *toughest,* and enduring performance is demanded, you can count on "Pittsburgh" for finishes with a "plus" over specifications!

Pittsburgh Aircraft Finishes include Camouflage Finishes . . . Protective Coatings for Wood and Fabric Surfaces . . . Zinc Chromate Primers for Metal . . . Lacquers, Clear and Pigmented . . . Dopes, Clear and Pigmented . . . Sealers and Surfacers for Wood . . . Plywood Finishes . . . Paints . . . Spar Varnishes . . . Heat-Resistant Enamels . . . Slushing and Sealing Compounds for Fuel Tanks . . . Caulking and Glazing Compounds . . . Chromseal Ribbon Compound . . . Fabseal Impregnated Tape . . . Chromseal Tape . . . Stratoseal Cabin-Sealing Tapes . . . Army and Navy Specification Finishes . . . Commercial Finishes for Post-War.

Martin B-26 Marauders

Chance Vought F4U-1D Corsair



Consolidated Vultee PBY Catalina

PITTSBURGH PLATE GLASS COMPANY, Industrial Paint Division, Pittsburgh, Pa. Houston, Texas; Los Angeles, Calif.; Portland, Ore. Ditzler Color Division, Detroit, Mich. The Thresher Varnish Co., Dayton, O.

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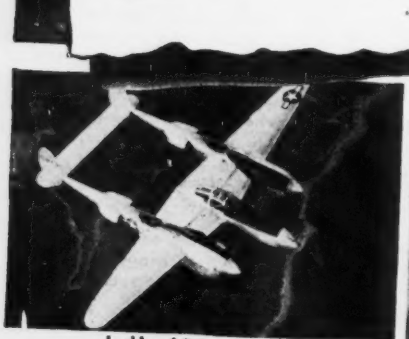
PITTSBURGH STANDS FOR QUALITY PAINT AND GLASS



Lockheed P-38 Lightning

Republic P-47 Thunderbolt

Bell-built Boeing B-29 Superfortress

From the Industry

Unit-Type Dust Collector

With an extra-thick, flat filter, instead of the familiar round-type, Model 1150 Dustkop is the latest addition to a line of self-contained dust collectors. Although designed for individual use on large-wheel dry grinders, disc grinders, sanders, etc., as well as polishing and buffing equipment, Model 1150 is also adaptable for simultaneous use on two or more wheels when the wheels are small and are grouped close together.

No duct work is required for installation, so the dust collector can be placed in operation within a short time and without the necessity for interrupting work in the department.

Because of its compactness (20 by 36 in. floor space), Model 1150 usually can be placed behind the grinder or buffer without moving the machines. The connection between dust outlets and collector can be quickly completed with flexible metal hose or standard sheet-metal pipe. With electrical connection into the starter circuit of the grinder, the installation is complete.

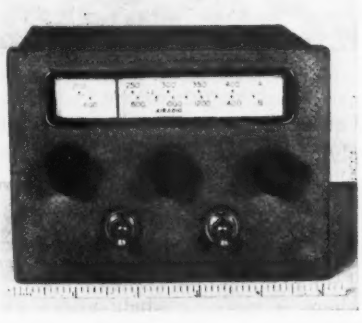
The Model 1150 is based on the principle of cleaning and recirculating the cleaned air back into the working space to save heat and prevent workers' complaints about drafts and the resulting colds. Dust, dirt, and lint from the source is drawn into the unit by a direct-driven, nonclogging paddle-wheel fan, which is direct-driven by a continuous-duty, 1½-hp., 3,450 r.p.m. motor. A Cyclone separator contained within the unit separates most of the dust and dirt out of the air streams, the extreme fines being removed by the spun-glass filter before the air is returned to the working space.

A hand crank on the end of the cabinet is provided for shaking the fine dust from the filter so that it can be brushed down the stack hole and into the dust-collecting bin. The latter, occupying the entire bottom of the cabinet, has a dust drawer to permit easy removal and disposal of the collected dust, dirt, lint, bristles, etc. Renewal of the spun-glass filter material, which is required only at infrequent intervals, is said to be inexpensive and to require only a few minutes.

The unit is available with motors for operation on virtually any type of power and can be supplied with inlet sleeves for various sized connections to one or more dust sources. Aget-Detroit Company, Ann Arbor, Mich.

New Two-Way Radio for Light Planes

Final production plans have been announced for a receiver-transmitter unit weighing only 10 lbs., 10 oz. Designed for private aircraft, this two-way communication system is said to be not only compact but also highly sensitive and ruggedly constructed. Excellent performance and dependability under all flight conditions are claimed for the two-band aircraft receiver and the transmitter. The set offers standard plane-to-ground communication, radio range, weather broadcast, and standard broadcast reception, as well as interphone between pilot and passengers.



Airadio Incorporated's new two-way light-plane radio.

A space the size of a postcard is stated to be all that is necessary on the aircraft instrument panel for mounting the receiver. The edge-lighted slide rule dial is accurately calibrated and simplifies tuning. The transmitter does not have to be accessible in flight and may be installed in a remote location.

A radio-range filter is incorporated into the receiver. When listening to a weather or other voice broadcast from an airways simultaneous radio-range station, the range signal can be eliminated by flicking a toggle switch located in the front panel of the receiver. This permits reception of voice only. A band selector switch is conveniently located on the panel board, which allows tuning in on standard broadcast while in flight. Although the set is light in weight, it uses full-size components, including standard metal and lock-in type tubes. Airadio Incorporated, Stamford, Conn.

New Tool Steel

A new tool steel is reported to provide from 25 to 200 per cent faster machinability. Identified as "Dunkirk EZ," it is a free-machining steel, which is described as being outside the usual steel specifications, with great possibilities in fields of cold-work applications and tool-steel machined parts. It is stated that it will harden to about 65 Rockwell C when it is quenched in oil from 1,450 to 1,550°F.; may be tempered up to 500°F. without softening under 60 Rockwell C; and is rather deep hardening. Allegheny Ludlum Steel Corporation, Brackenridge, Pa.

Improved Steel Work Bench

Streamlined design and sturdier construction are among the features attributed to an improved 12-gage steel work bench. The unit may be obtained without back and side railings for use as a packing bench.

All four flanges of the bench are formed into a boxed edge for rigidity. A second 12-gage steel plate may be tack welded onto the top for vice reinforcement. The bench is suitable for both work-bench use and for supporting light machine tools. The four feet have holes to permit fastening to floor if desired. Available in 42-in. and 6-ft. lengths, 34 in. high and 28 in. deep, the unit can be supplied as a plain work bench with 12-gage steel top and with bottom tray, back and side railings, drawers with padlock attachment, and an adjustable three-compartment tray for drawer. Aurora Equipment Company, Aurora, Ill.

Plasticaps

Plasticaps have been developed for use by industries employing beaded tubing or tubing with swaged collars for positive attachment of hose connections. The function of these plastic seal caps is to provide a tight, dustproof seal at both ends of the tubing to keep out foreign matter. These caps stay on during subassembly operations until the final hose connection is made. A positive joint is effected, preventing scuffing of particles from the inside of the cap. As the caps are snapped on with thumb pressure, the circular grippers move out over the bead and inward to hold a tight seal.

While made of plastic, these caps are said to have an action similar to a spring-steel clip. They eliminate the possibility of assembling a hose over the tube end without first removing the seal.

Philadelphia Evening Bulletin Photo

Men and women stop to marvel at a helicopter. There is something miraculous about a machine that hangs or moves in the sky without wings or propeller. And flies forward, sideways or backward—hovers in one spot—rises or descends vertically, linking air travel with the ground, to make flying an easy step to anywhere.

The helicopter's high crowd appeal was shown (above) a few months ago in a demonstration of the Kellett XR-8 military model at Fairmount Park, Philadelphia, under sponsorship of the U. S. Army Air Forces.

With the ease of a hummingbird, the XR-8 flew in, high over the crowd, and settled to rest in a space only 100 feet square. Then the helicopter soared straight up, backed, swung from side to side like a pendulum, whirled, hovered. Finally it sped forward, at a faster clip than a motor car let loose on an express highway, in complete mastery of speed, height and direction.

Just what the public's keen interest in helicopters will mean in future industrial and commercial uses for this unique type of machine is more than we at Kellett Aircraft can forecast. As the oldest American designers and producers of rotary-winged craft, we consider one of the helicopter's most valuable features something we did *not* design or make—its inherent "crowd appeal," even to a nation which accepts modern streamlined trains and 400 mile-an-hour airplanes without a second glance.

Operating details, including cost and payload, may postpone the widest practical application of the helicopter. However, specialized money-making applications seem close at hand. Kellett Aircraft and other important organizations in the helicopter field are devoting time, money and experience to hasten the day when these craft will meet the expectations of their most loyal boosters — the American public. Kellett Aircraft Corporation, Upper Darby, Pa.

KELLETT HELICOPTERS

It is claimed that they will not mar or scratch either the tube sealed or adjacent tubes in a bundle, that they can be used many times, that they are quickly and easily applied or removed, and that the "per use" cost is lower than that of seals that entail more time and labor.

Plasticaps are supplied in various colors to facilitate the sorting of different sizes for re-use. They are made in eight sizes to fit tubing diameters of 1/4, 3/8, 1/2, 5/8, 3/4, 7/8, 1, and 1 1/4 in. Aviation Service Corporation, Oklahoma City.

Plug Connectors

A new type of plug connector with multiple-fingered spring inserts provides uniform pressure on long-wiping contacts. Known as the Lok-Plug connector, the device is produced for from one through 80 circuits, but practically any number of single- or multiple-circuit connections can be furnished in any vertical or horizontal arrangement desired. Circuits are marked to denote single or multiple types. It is suggested by the maker that a major space-saving will result when circuits are stacked in two, three, or four tiers or vertically extended.

Connectors in all sizes are furnished for surface or flush mounting. They are available for simple snap-on installation and ready removal without the use of holding screws. The basic elements of the Lok-Plug connectors are used to form a quick and efficient splice, known as the Featherweight Splice.

Plugs accommodate all wire sizes from No. 26 through No. 12. Size 10 wire uses a larger plug bore. To facilitate circuit identification, insulation sleeves are available in six solid colors and in numerous color combinations. Butting against the molded receptacle, these sleeves make each connector a completely "dead-front" unit. These plugs are recommended by the manufacturer to replace screw-type connectors and to reduce installation time in applications up to 30 amp., 250 volts on aircraft, marine, and commercial equipment of all kinds. Buchanan Electrical Products Company, Inc., Erie, Pa.

"Multi-Drill" Attachment

The "Multi-Drill" is a new six-spindle, universally adjustable multiple-spindle drilling attachment. It is claimed that this attachment can be easily and quickly installed on most types of drill presses. The device comprises a driving head with six movable spindles, each of which is located by an individual radially adjustable arm. This design permits the positioning of drills up to 17/64 in. in diameter in any hole pattern, including a straight line, within a 5-in. diameter circle with minimum distance between centers of 11/16 in. From one to six holes can thus be drilled simultaneously in one stroke of the drill press.

The housing for drive gears and the supporting frame and adapters are of special high-strength aluminum alloy. The entire attachment weighs 13 lbs.

Releases are printed as received from companies and other aeronautical organizations and the responsibility for the accuracy of all statements is therefore not assumed by the Aeronautical Engineering Review.

Modifications of the attachment are obtainable for special applications. Commander Manufacturing Company, Chicago.

Trimmer Amphibian

The Trimmer amphibian is announced by Commonwealth Aircraft, Inc. Twin-engined, with a reportedly better-than-average light-plane cruising speed, this amphibious high-wing monoplane has a built-in galley and two bunks. It is powered by two 85-hp. Continental engines of the horizontally opposed type, set in the leading edge of the wing. Top speed of the Trimmer is stated to be 132 m.p.h., cruising speed 115 m.p.h., and cruising range up to 600 miles. Its wing span is 35 ft. 6 in., length 24 ft. 10 in., and height 8 ft. 7 in. (on wheels). The weight empty, with standard equipment, is 1,470 lbs., gross weight 2,200 lbs. Landing speed is 48 m.p.h.

Standard equipment has the normal complement of flight instruments, which includes a battery, starters, and lights. Provision is made for the installation of two-way radio. Landing flaps may be operated from both of the dual control positions.

On water the amphibian takes off in 635 ft. into a 6 m.p.h. wind, fully loaded. Fuel consumption is 9 plus gal. per hour. It is stated that the Trimmer will continue in level flight when operating on only one engine.

The cabin serves as the main float for water landings, with a small streamlined float built into each wing. Landing wheels are retractable. Commonwealth Aircraft, Inc., Kansas City, Kan.

Molded Silastic Parts

Silastic parts—gaskets, seals, hose, rubber-to-metal adhesion and miscellaneous pieces—are now available commercially. Heat resistance is the outstanding physical characteristic of the material, which withstands temperatures from −70°F. to +500°F., while retaining its original resilience and flexibility. Its dielectric properties—arc, corona, and oxidation resistance—are said to assure durability under severe service conditions. Although opening many new prospects for designers of essential equipment, parts made from Silastic must be carefully designed and frequently reinforced with glass fabric. Connecticut Hard Rubber Company, New Haven, Conn.

DC-8 Transport

A new Douglas commercial transport, known as the DC-8, will be 50 per cent faster, carry twice the number of passengers, and reduce direct per passenger-mile operating costs to one-half that of the builder's DC-3 type which for 12 years has been standard equipment on many of the world's air lines. It is featured by wings that are free from the drag imposed by engine nacelles and by twin counterrotating propellers mounted astern of the fuselage. This application to aircraft of a basically new principle of "centerline thrust" is credited by the designers with certain improvements over conventional types in speed, safety, climb, and efficiency.

The DC-8 is a low-wing monoplane of gross weight of 39,500 lbs. Its useful load of 15,585 lbs. accommodates 48 passengers, luggage, mail, express, and general cargo. A cabin innovation is a movable partition that converts the craft at short notice from an all-passenger unit to a combination passenger-cargo plane designed to secure for each flight a 100 per cent load factor.

Other advantages for passengers over conventional craft made possible by the new principle of propulsion are listed by the manufacturer as follows: reduction in the cabin noise level, attributable to the remote location of propellers; no wing engines or nacelles to restrict window vision; exhaust smoke, flame, and sparks not visible; a cabin floor level only 60 in. above ground for easy entrance and egress.

Advantages claimed from the standpoint of design include improved single-engine performance, with no offset thrust in case of failure of one engine; an overall drag coefficient 25 per cent less than an equivalent conventional plane; a higher rate of climb made possible by the 15-ft. propeller diameter and increased efficiency of the propellers' location aft; better lift distribution resulting from the higher effective wing span; elimination of weight from the shorter landing gear and hydraulic mechanisms; higher pay load resulting from the combination of these features; and lower ground costs. Passengers may be admitted and discharged without shutting off the engines, since the propellers are aft and there is no propeller blast at the loading point. This also eliminates the necessity for mechanics to work in a slipstream while making adjustments. Since the engine and accessory cowling opens like a bomb-bay door, all maintenance items are readily accessible at waist level from the ground. Engines also are accessible in flight.

The DC-8 will be powered by two Allison V-1710, 1,600-hp. liquid-cooled engines mounted in the fuselage below the forward cargo-compartment floor. The two engines are connected with the two counterrotating coaxial propellers by drive shafts and a gear box similar to those of an automobile. Allison engines were chosen because they were installed in military experimental prototypes that have been test-flying for more than a year but it is stated that other

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TORQUE WRENCH
-HEAR-FEEL-SEE-

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THEY GAVE "OSCARS"
STURTEVANT Torque Wrenches would win highest honors . . . for outstanding performance . . . for permanent accuracy . . . for dependability and long tool life . . . and for the development of the Sensory Wrench with "Reflex Torque Control"—a truly great contribution to modern manufacturing.
Industry's recognition of P. A. STURTEVANT CO's achievements has made this firm the world's largest manufacturer of Torque Wrenches.
WRITE FOR BULLETIN SW-1

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ADDISON QUALITY ILLINOIS
THE WORLD'S LARGEST MANUFACTURERS OF TORQUE WRENCHES

THE FEATHEROAK? THERE'S NO SUCH THING . . BUT
Skydyne
SANDWICH CONSTRUCTION
IS
LIGHT AS A FEATHER . . .
STRONG AS AN OAK . . .

. . . a combination which makes Skydyne a "must material" for any airplane designer or decorator to investigate. Skydyne is perfectly suited for luxurious airplane furniture and all other interior equipment.
For example, in giant commercial airliners, "SKYPLY", Skydyne Sandwich Construction, can be used for the attractive furnishing and finishing of cocktail lounges, reading rooms, game rooms, rest quarters, frozen food compartments and storage accommodations.
Adaptable to all types of designs because it is form moulded, Skydyne offers a beautiful, smooth, rivet-free surface, with curvatures easily attained. It is highly resistant to heat, cold, moisture, vibration and sound.
Learn the whole story about this and many other uses of Skydyne Sandwich Construction — now available for peacetime applications.

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Skydyne Inc
PORT JERVIS, NEW YORK
"SKYPLY"

engines could be easily substituted when suitable versions for this type of plane are available.

Paralleling development of the DC-8 is a cargo version that is designed to provide low operating costs per ton-mile. It will have a reinforced cargo floor and large loading doors both fore and aft.

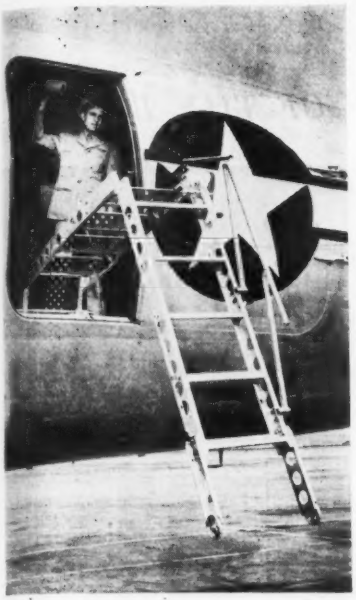
The Curtiss electric propeller installed on the Douglas DC-8 is stated to be the only one of its type in the world, being a dual rotation propeller in which the fore and aft elements are "divorced" or independent of each other. On the DC-8 installation, the propeller is installed on coaxial shafts but is driven by two engines through a gear box. The aft propeller of the combination is driven by one engine and the forward propeller is driven by the other engine. Each propeller has its own pitch-changing power source. The propeller is designed to permit the use of blade angles that will result in negative or reverse thrust for aerodynamic braking.

Specifications of the DC-8 are as follows:

Span	110 ft. 2 in.
Wing area	1,104 sq.ft.
Length	77 ft. 10 in.
Height overall	25 ft. 9.5 in.
Maximum take-off and landing weight	39,500 lbs.
Weight empty	23,915 lbs.
Useful load	15,585 lbs.
Per cent useful load/gross weight	39.4
Engines:	Allison V-1710
Take-off power	1,600 hp.
Rated power	1,200 hp.
Maximum cruise power, 10,000 ft.	1,025 hp.
Performance:	
Maximum cruise speed, 10,000 ft.	270 m.p.h.
Maximum two - engine climb	
Sea level	1,030 ft per min.
10,000 ft.	840 ft. per min.
Maximum one - engine climb	
Sea level	285 ft. per min.
10,000 ft.	145 ft. per min.
C.A.R. field length, sea level	
Take-off	3,950 ft.
Landing	3,960 ft.
C.A.R. one - engine operating altitude	12,000 ft.
**Economy:*	
Pay load at 300-mile range	12,000 lbs.
Including Passengers	48 max.
Cargo in excess of baggage (at not more than 10 lb/cu.ft.)	2,400 lbs.
Block-block speed at 300 - mile range (against 10 m.p.h. headwind)	223 m.p.h.
Direct operating cost per plane mile	41.6 cents
Direct operating cost per 200 lb.-mile	0.695 cents

* All economy information is calculated by the methods recommended by the Air Transport Association.

Douglas Aircraft Company, Inc.



The electrically operated collapsible gangplank used on the Douglas Skymaster staff transports.

Collapsible "Gang Plank" Ladder

Douglas Skymaster staff transports for high Government officials now carry their own "gangplanks" in the form of a lightweight collapsible metal ladder stowed beside the main cabin door. The ladder is electrically operated. A small motor mounted on a short track over the door causes the ladder to fold up or unfold in "grasshopper leg" manner. Douglas Aircraft Company, Inc.

Powerful Light Used During War

The development of a small, portable light with a beam comparable to that of the Lindbergh beacon is reported. The light, which enables fliers and ground crews to establish identification, has been in active combat use for several years but details about it have been revealed only recently.

The light emits a flash only $^1/_{20,000}$ sec. in duration, but of approximately 30,000,000 candlepower. The beam is visible for a distance of 35 miles at night and can be seen more than 3 miles even in brilliant sunlight. Because of its great penetration, it is of value to planes flying at 15,000 ft. or higher. It is small enough to be carried by a soldier on foot, or may be mounted on a plane, jeep, or tank. Used in connection with a code system, this light also enables planes in the air to determine the position of their own troops without disclosing this position to the enemy. Electronic Laboratories, Indianapolis.

Rotasleeve for Large Flows

The Rotasleeve utilizes the basic advantages of the area-type flowmeter for the measurement of large flows of liquids and gases. A development of the Rotameter principle, this new instrument is credited with high accuracy, straight-line calibration, wide flow range, low pressure loss, instantaneous response to flow changes, and economical cost.

The Rotasleeve is a tapered metal sleeve that fits into standard pipe tees of sizes 3 in. and larger. The flow enters the bottom of the Rotasleeve, causing the flow-indicating float to move upward and to assume a position in direct proportion to the actual rate of flow. Flows as large as 14,000 gal. per min. of liquid and 16,000 cu.ft. per min. of gas can be handled. The Rotasleeve is made for direct reading, and for remote reading in recording and recording-controlling types. Fischer & Porter Company, Hatboro, Pa.

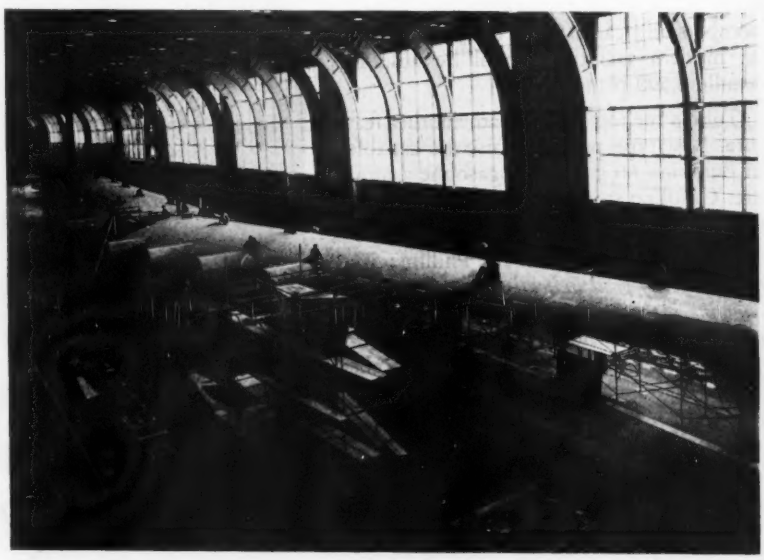
Large Cargo Seaplane

The Hughes H-4 cargo seaplane is built almost entirely of wood. Regular aircraft birch, purchased in Wisconsin and Michigan, was selected on the basis of past experiments with other planes and because of the strength-weight ratio. The builder secured a franchise to use the Duramold process of wood lamination. N.A.C.A. engineers at Langley Field were consulted on the design of the hull, to obtain the best results in hydrodynamic characteristics. Several of the builder's aircraft engineers made a trip to Langley Field for this purpose and the basic lines for the hull bottom were determined there.

Although birch is used mainly, other woods such as spruce, poplar, and maple were employed, as well as some balsa for fairings. All birch parts are made from veneer varying from $^1/_{64}$ in. to $^1/_8$ in. thick and laminated together with glue. Because of the lengths of most parts, it was also necessary to scarf ends of veneers together before lamination. Birch billets for the wing spars are 6 in. by 8 in. by 9 ft. Most spruce parts are made from solid stock, but the longeron billets are built up of $^3/_{16}$-in. laminations and are 10 in. by 10 in. by 100 ft. Because of the size and quantities involved, it was necessary to design and build special scarfing cutters and presses. These scarf cutters were set to make scarf joints to tolerances never before attained in wood construction. In laying up billets, veneers were scarfed together selectively so that the variations in thicknesses of adjoining veneers would not culminate in glue lines of excessive thickness. It was found that the larger the part, the greater became the necessity for accurate moisture control during manufacture. All wood was preconditioned before use, then gluing was done in buildings held at constant humidity and temperature between 72° and 80°F. Part of the skin on the horizontal and vertical stabilizers is made of poplar plywood. Plywood skins with sharp or double curvature were made in the builder's own press or by outside contractors. Extensive use is made of plywood angle sections.

Three different types of resin glues are used throughout the airplane. The plywoods used on the outside surfaces, as well as in other parts of the structure, are bonded with a phenol formaldehyde resin which is cured by heating to 300°F. The laminate members, such as spar caps, stringers, longerons, and stiffeners are built up from veneers using a urea formaldehyde resin of the type curing at 70°F. or above. This same resin is used also for most of the assembly work. Another resin, the medium-temperature resorcinol formaldehyde type, became available after the project was well under way and was used in making the joints in the hull skin.

The hull is of all-wood construction with the exception of a few metal fittings. The skin bulkheads and frames are of all-birch construction while stringers are of composite birch and spruce design. Parts such as bulkheads and frames are fabricated by gluing the



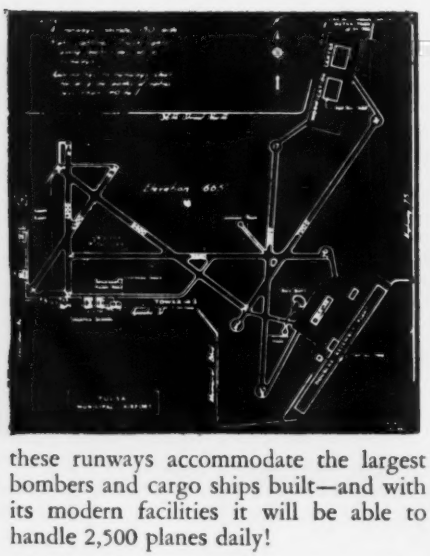
The wing panels of the Hughes H-4 cargo airplane in dihedral position during mating.

Tulsa Municipal ONE OF THE BIGGEST, BUSIEST AIRPORTS OF 'EM ALL PICKS *PHILLIPS*

WE want you to know about an airport and staff that is on its toes, alert, and progressive as they come!

The Tulsa Municipal Airport isn't just a post-war dream...it's a present-day reality.

Previously restricted because of military security, these are the facts of this tremendous operation: It comprises 1,680 acres of land. It has six concrete runways, 8.5 miles in total and 150 feet in width;



these runways accommodate the largest bombers and cargo ships built—and with its modern facilities it will be able to handle 2,500 planes daily!

Tulsa's fueling facilities are another feature. New-type pumps in use are capable of pumping 80 gallons of gasoline a minute. Gasoline storage tanks have been increased in capacity to 100,000 gallons.

Now, here's the pitch for Phillips: *We think a pretty good indication of an Aviation Gasoline is the kind of people and places that use it.* We think the fact that Tulsa Municipal Airport is a Phillips customer speaks louder than all the product claims in the world.

We *earned* this confidence . . . we'd like a chance to earn yours. If you have a problem which involves aviation gasoline, why not let us take a crack at it? Just write to the Aviation Department, Phillips Petroleum Company, Bartlesville, Oklahoma.

(Above) Main administration building at the Tulsa Municipal Airport—one of the most attractively designed buildings to be found at any airport.

(Left) C. W. Short, Jr., Manager of the Tulsa Municipal Airport since its inception in 1928, and well known throughout the aviation industry.

Phillips
AVIATION GASOLINE

1993*

component parts together, using clamps for pressure. Glue pressure for skinning is obtained by nailing skins in place with thousands of small nails which are removed after the glue is cured. The cargo floor was designed to carry a load of 125 lbs. per sq.ft. The bottom skin is 1/2 in. thick and is designed to take much higher bottom pressure than those used on smaller flying boats.

The hull below the cargo deck is divided into 18 watertight compartments. If two-thirds of these were flooded, the craft would still remain afloat. The main fuel tanks are housed in these compartments so that if a tank should leak the gasoline will not spread to other parts of the craft. The exterior of the hull is finished with a special process. It consists of one coat of wood filler, one coat of sealer that acts as a cement for a coat of thin tissue paper placed over it, followed by two coats of spar varnish and one coat of aluminized spar varnish.

The engines are installed on the leading edge of the wing. Through a passage in front of the front spar, and then through the nacelles and fire-wall doors, the flight mechanic may inspect and make minor repairs and adjustments on each engine. All fuel, oil, hydraulic, and pneumatic plumbing is routed along the spar, providing for quick inspection. The nacelle structures are of wood and are mounted on the front spar by welded steel tube adapters. All cowling and other structures forward of the fire walls are of metal.

Cooling air for the oil coolers and carburetor-charge air are taken into their systems from scoops underslung on the nacelle. The scoop fairings also enclose the oil coolers. A small oil tank sufficient to supply the engine for a reasonable time is located in each nacelle and may be refilled at any time from a central oil reservoir by a semi-automatic control system. The engines are fitted with "jet stacks" in an effort to convert as much of the exhaust gas energy into thrust as possible. Hydromatic, full-feathering, four-blade propellers, 17 ft. in diameter are used, with the four inboard propellers also capable of being adjusted to produce reverse thrust, to provide greater maneuverability on the water and assist in reducing speed after landing if necessary.

Fourteen fuel tanks of over 1,000 gal. each store fuel in the hull. Two transfer pumps supply fuel from these tanks to a service tank in each wing. Each tank supplies fuel to four engines, selected to give a lateral balance of power in the event that one tank, its booster pump, or other parts of the system should fail. In addition to this regular fuel-supply system, a complete and separate system providing enough fuel to all engines for maximum power is immediately available from the hull storage tanks for emergency use.

The engineers responsible for designing the engine controls adapted the Pneudyne, which has long been used by the railroads for brake-control equipment. The Pneudynes are devices using compressed air for precisely transmitting very small motions at long distances. Any position of the lever on the transmitting Pneudyne is maintained accurately on the receiving Pneudyne, for indefinite periods of time, even if the atmospheric temperature and pressure change during flight. The pneumatic system is completely enclosed, requiring only a small amount of make-up air, and is equipped with moisture-absorbing devices to safeguard against freezing. All engine controls are actuated by the Pneudynes from the flight engineer's station, the pilot controlling only the engine throttles.

The control surfaces are actuated by a hydraulic telecontrol system, which is not only capable of transmitting the pilot's motions to the control surfaces but, being reversible, it also signals gust forces back to the pilot, thereby anticipating the impending change in the attitude of the craft while flying. Each control surface is operated by two independent self-contained telecontrol systems supplied with electric power from separate generators. In case of failure of one of the hydraulic systems, the remaining one is capable of automatically taking control and operating the control surface under all conditions of flight. The pilot's and copilot's flight controls in the cockpit are conventional-type controls with a column and wheel for the elevator and ailerons. The rudder pedals are made so they have a motion parallel to the floor, similar to the old-type rudder bar. The trim tabs are operated electrically by toggle switches that move in the direction in which the plane will respond. Attached to the trim tabs are electric linear actuators that move the tabs.

Condensed specifications are as follows: wing spread, 320 ft.; wings are 13 ft. thick at hull; hull, 220 ft. long, 30 ft. high, 25 ft. wide; power, eight engines, 3,000-hp. each, with four-bladed propellers, each 17 ft., 2 in. from tip to tip; fuel, 14 tanks, each to hold 1,000 gal. gasoline; high speed at sea level, 218 m.p.h.; cruising speed, 175 m.p.h.; landing speed, 78 m.p.h.; distance of take-off about 5,500 ft.; gross weight, over 200 tons. The airplane was designed to carry one 60-ton tank or three light tanks. It can accommodate 350 hospital patients in stretchers with doctors, nurse, and surgery equipment. Hughes Aircraft Company.

Pre-Selectric Power Feeds

A "Pre-Selectric Power Feeder" automatically duplicates the operations of a skilled mechanic when deep drilling or tapping small holes, providing automatic chip clearance at preselected depths during the drilling or tapping operation. The machine mounts by means of a bracket on the drill-press column and by attaching a collet to the drill-press spindle feed shaft. Positioning of the power feeder is not critical, being governed by the alignment of the collet with the spindle feed shaft. The weight of the unit is balanced on its support arm, no weight being added to the drill-press spindle-feed shaft bearings. Installation can be accomplished in less than 10 min. by one man.

It is claimed that the Pre-Selectric feeder will consistently drill No. 50 holes through alloy steel plate to the full length of the drill without drill breakage and with substantially less dulling of the drill than when controlled by hand.

All controls on this power feeder are available from the normal position of the operator in front of the drill press. The three switches at the top of the panel are: (1) On-and-off switch for automatic operation; (2) up-and-down control switches, the "down" switch starting the cycle and the "up" switch reversing the spindle, returning it to the up position at any desired point in the operating cycle; (3) the main power switch in the upper panel. The lower row of edgewise control dials are the limit dials controlling the depth of the drill as to top and bottom limits and the extent to which the drill is raised for chip clearing. The drill may be partially or fully raised from the hole to clear chips. A timer is provided to control the length of drilling time between chip clearances, exactly duplicating a hand drilling operation. To the right of the timer is a pressure-adjusting knob that sets the amount of pressure on the drill, thus controlling the rate at which the drill is fed into the work. The unit operates on 110-volt single-phase or 220/440-volt three-phase current.

When used with any standard tapping head, the unit becomes a precision automatic tapper. The tap is lifted high enough for chip clearance, but not completely removed, which is stated to be of particular advantage in "blind" tapping when a chip driver ahead of the tap is a disadvantage. The machine is also used for honing, lapping, and reaming. It permits hopper-feed of work to the drilling fixture, with the operating cycle controlled by energizing a circuit through the feeder to assure proper positioning and electrical interlocking of the work. James H. Knapp Company, Los Angeles.

Automatic Lathe for Small Jobs

The 2A Duomatic automatic lathe has been developed for full automatic handling of small work. It is specially designed for quantity production of lathe work arranged between centers, on an arbor, or in suitable chucks or fixtures. It is equally adaptable, the manufacturer claims, to efficient handling of small runs.

As the name implies, this lathe is dual in construction. There is a complete front carriage and tool slide, and a complete rear carriage and tool slide, each independently actuated from its own feed screw. The feed and traverse mechanism provides rapid forward and return traverse, a wide range of mechanical feeds from pick-off gears, pause adjustment, and graduated dial for determining the length of power-forward traverse. Provision is made for disengaging the power feed whenever necessary during the cycle to return the tools to the start-of-cycle position. A separate clutch lever enables the opera-

HASKELITE'S PART IN TAKING TOKIO APART

Photo by Air Technical Service Command

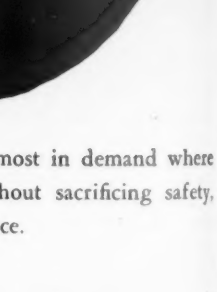
MOLDED *FIBERGLAS ANTENNA COVERS . . . FLY WITH B-29s

The Haskelite-produced parts pictured above were molded by Haskelite from *Fiberglas impregnated with low-pressure resins, and molded to specifications in volume quantity.

Here is a typical example of how Haskelite creates materials with a quality better than materials previously used which were higher in cost and more difficult to fabricate. Haskelite *Fiberglas laminates contain the qualities and advantages necessary for it to be classed as an outstanding aircraft material, as is Haskelite Aircraft plywood, Haskelite Plymold, Plastiply and Phemaloid, whose qualities have made them most in demand where weight must be saved without sacrificing safety, dependability or performance.

* Trade mark registered by Owen-Corning Fiberglas Corp.

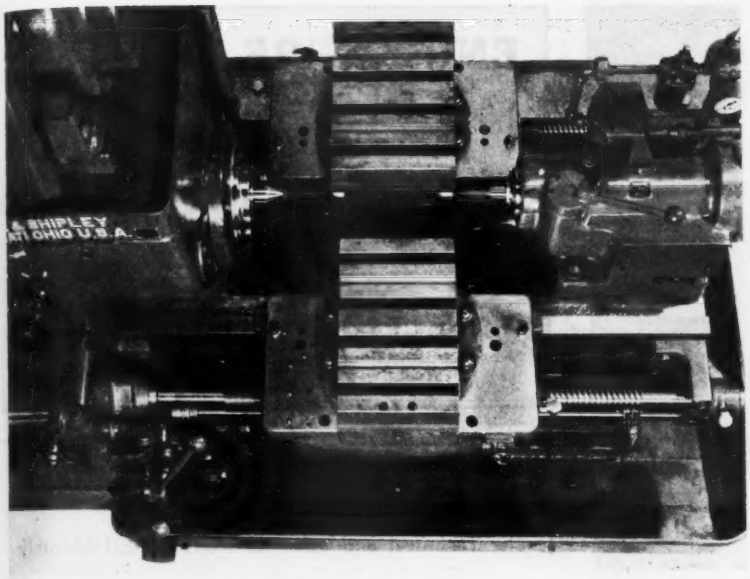
Write for Bulletin S45 for additional facts on Haskelite laminates and other Haskelite materials that will help you design products which will be built better . . . look better . . . and sell better. Samples will be sent on request.



HASKELITE MANUFACTURING CORP., Dept. A-5, Grand Rapids 2, Mich.

NEW YORK CITY DETROIT, MICH. CHICAGO, ILL. ST. LOUIS, MO. CLEVELAND, O.

In Canada: Railway & Power Engineering Corp., Ltd.



The front and rear carriages and tool slides of the Lodge and Shipley Machine Tool Company's new Duomatic lathe are clearly shown in this vertical view of the lathe.

tor manually to set up the required cycles through rotation of a handwheel at the tailstock end of each feed screw. Control levers enable the operator to start the spindle and the cycles independently from the front or from the rear, or simultaneously from the front. All setups are mechanical, no cams being required to change cycles.

Other construction and operating features are: Tool slides can be swiveled to any angle on graduated tool slide base. Wide, double wall bed with elliptical girths assures rigidity. Automatic lubrication to headstock, driving pulley, and feed and control mechanism. Heavy duty tailstock with built-in revolving center. Graduated dial adjustment for determining amount of power-forward traverse. Pause at end of cut. Stopping of spindle during cycle stops both carriage and tool-slide travel.

Principal specifications are: Swing over bed, $20^3/_4$ in.; swing over front or rear cross slide, $9^1/_2$ in.; base length of machine 15 in.; center distance can be increased in increments of 6 in. up to 27 in., and 12 in. beyond 27 in.; hole through spindle, $2^1/_8$ in.; range of feeds, 0.003 in. to 0.050 in.; range of spindle, speeds dependent upon change of gears and driving pulley selected, 50 to 2,000 r.p.m. Motors are 5 to 20 hp. The Lodge and Shipley Machine Tool Company, Cincinnati.

Hard-Alloy Thread Plug Gages

A line of thread plug gages is being manufactured from tantung, a nonferrous hard alloy. It is claimed that these thread gages not only outlast those made of hardened steel, but also give considerably better performance than gages of other nonferrous alloys.

Tantung is a hard, strong, tough alloy containing cobalt, tungsten, chromium, and tantalum-columbium carbide. The latter imparts a self-lubricating action that increases its resistance to wear. Dense and fine-grained, the material takes a high finish. It is nonresisting, nonmagnetic, and is not corroded by moisture or any of the common acids or fumes. Master Gauge Company, Detroit.

Positioner Holds Work at Any Angle

The purpose of the new Model S Metro positioner is to simplify the tilting of work during various assembly operations, by permitting the angle of tilt to be adjusted almost immediately and without the necessity for stopping work to manipulate a wrench. In principle, the existing vise or fixture is bolted, or otherwise secured, to the "place plate" of the positioner. This plate is integral with a ball turning in the socket formed by two clamping jaws, so shaped and pivoted as to maintain a firm grip of the ball, yet so "tensioned" as to let the ball "roll" in the socket when a change in the angle of tilt is desired. Holding pressure exerted on the ball is supplied by a heavy tension spring, which actuates the two clamping jaw members.

Pressure by the babbitt jaws is sufficient to hold the ball in shiftproof position during normal assembly operations. However, when the vise or fixture is to be given a different angle, the ball is responsive to simple hand pressure. There are no fixed graduations; therefore any angle and any direction is obtainable. The Model S positioner is supplied in two sizes. Metro-Vise Company, Detroit.

Improved Die-less Duplicating Machines

Three redesigned Di-Acro Bender models incorporate several major changes and improvements over the originals. Operating friction has been reduced in the new models by the installation of Torrington roller bearings, which increases the ease of operation approximately 35 per cent and adds forming capacity to the units. Another added feature is the instantly reversible lever control cam, allowing the operator a choice of either right- or left-hand forming direction.

Interference, which may develop when forming several intricate shapes successively in a single piece, can be quickly eliminated through this two-way operating feature by simply reversing the forming direction of the machine. O'Neil-Irwin Manufacturing Company, Minneapolis.

Deburring Engine Cylinder Barrels

An application of power brushing is being utilized in the deburring of airplane-engine cylinder barrels. The power brushing method replaces an operation that was previously performed on a speed lathe where the edge burrs were removed from the fins with strips of emery cloth, an operation that used to take 5 min. to complete the deburring of one barrel.

The new brushing operations are set up on an automatic machine using three stations. On the first three stations Monitor brushing wheels of 0.005-in. wire are assembled side by side to build up a face, or brushing surface, of 6 in.

A burring compound is used in conjunction with the brushing wheels to remove the burrs. On a fourth station, another power brush of treated Tampico sections is assembled to form the same width of brushing surface and operated without compound to wipe off any excess that might be left after the deburring operation. The Osborn Manufacturing Company, Cleveland.

Parts-Cleaning Machine

A new portable-type parts-cleaning machine, which agitates the cleaning fluid by air pressure, has been developed. With this unit no heat is required to remove grease, grime, and carbon from parts. Two systems of cleaning are combined in the one unit. Large parts to be cleaned are placed in the tank and the cleaning solution is agitated by means of air pressure. The air is dispelled from a series of holes in a pipe that runs lengthwise at the bottom of the tank.

Small parts such as screws, washers, etc., are placed in a round basket and soaked in the solution for a few minutes. The basket can be revolved or swished by hand. After the parts have been cleaned, the rack is placed on an attached drain shelf that drains the solution back into the tank for re-use. The parts are then blown dry by means of the air gun and rinsed with water or petroleum spirits. The machine is operated from the air-pressure line. Park Chemical Company, Detroit.

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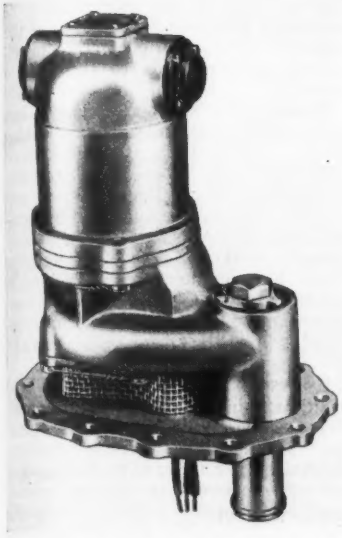


The new Pesco fuel booster pump for aircraft. The model shown is designed to operate submerged in the fuel.

Fuel Booster Pump for Bubble-Free Oil

To meet the demand for a fuel booster pump having more positive vapor-separating characteristics for handling larger fuel flow under more severe operating conditions, a new compact, electric motor-driven, centrifugal pump incorporates a design that provides for the delivery of bubble-free fuel.

The only moving element of the pump is a direct-driven impeller-rotor with tapered blades on one side and shrouded blades on the other. These shrouded blades in combination with an elliptical housing comprise a vacuum arrangement that draws off the vapor and eliminates it through a discharge port, leaving only solid fuel to enter the fuel line.

Various models are available for external mounting on the supply tank or for internal installation to operate submerged in the fuel. The pump is described as featuring positive vapor-control in rapid climb to high altitudes, stabilized delivery of bubble-free fuel, trouble-free bearing and seal arrangement, self-priming, and ability to pump the fuel tank dry. Pesco Products Company, Cleveland.

Planetary Milling Machine

A new planetary milling machine designed especially for low-cost thread and form milling is announced. A feature of this machine is its small size, less than 9 sq.ft. overall. It is stated that a complete part can be milled in one operation in as little as 8 sec. Since the part itself does not move, the revolving cutter being fed around the work, large parts can be handled with ease and speed. It is operated by means of an electronic control panel that may be mounted on the floor, wall, or ceiling. Plan-O-Mill Corporation, Hazel Park, Mich.

No. 3B Jig Borer with Large Built-In Rotary Table

A new feature that has been added to the P&W No. 3B jig borer is a large nondetachable precision rotary table built into the machine. Two table sizes are available, either 42 in. or 48 in. in diameter. This makes available equipment for precision boring to polar coordinates on large work, in addition to regular rectangular coordinate work. Either type, or both, can be handled without change in setup. The new large, built-in rotary table replaces the regular plain rectangular table on the machine, and is finished to close tolerances. The table is equipped with a precision worm indexing mechanism that provides excellent accuracy for average work. For still closer accuracy, a spacing system may be provided in the outer rim.

Power is provided for indexing the rotary table, in addition to the regular horizontal and transverse power traverse on the machine slides. Suitable binders lock the table in position solidly while work is being bored.

Work capacity of the two built-in tables is large. Either will handle holes bored on a diameter of $53\frac{1}{2}$ in. The largest outside work diameter that will clear the column ways is 71 in. If the work will fit into the gap below the column ways (less than $14\frac{1}{8}$ in. above the table) the maximum outside work diameter can be increased to 89 in. The standard distance from the table top to the spindle nose is $24\frac{1}{8}$ in. Both this and the gap distance can be increased as desired by using raising blocks under the machine column.

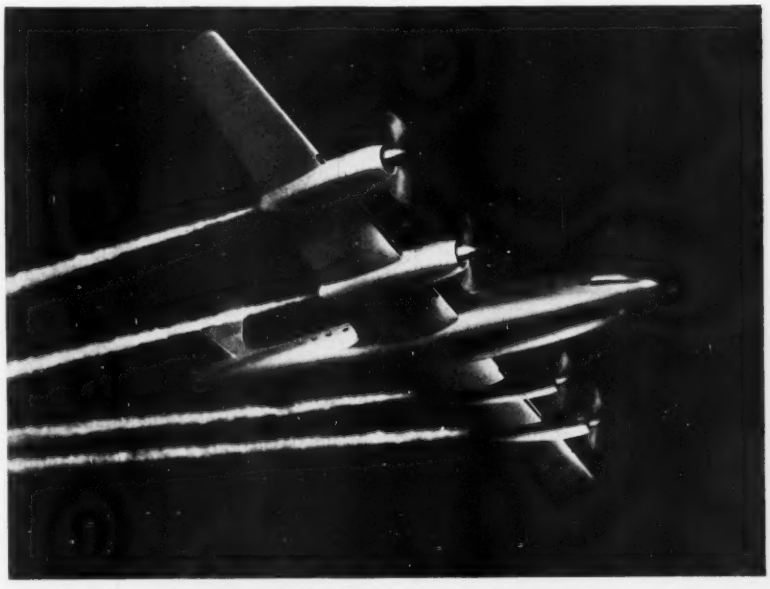
The general construction of the new tables is rigid and provides for handling large jigs, fixtures, and tools. The machine will also function for certain precision milling jobs within the limitations for which the jig borer can be expected to be used for this type of work. Pratt & Whitney Division of Niles-Bement-Pond Company, West Hartford, Conn.

Aircraft Radio Receiver

A new lightweight radio receiver designed especially for private aircraft is designated as Model 117. This receiver is a five-tube superheterodyne with automatic volume control, coaxial lead-in and antenna-matching transformer, and other features usually found only in larger radios. It is stated that its sensitivity and selectivity are greater than anything available to the private flier before the war. The receiver is cubical in shape and measures $3\frac{3}{4}$ in. on each side. Its weight is 1 lb. 12 oz. The battery pack measures $2\frac{3}{4}$ by $2\frac{3}{4}$ by $6\frac{1}{2}$ in. The receiver may be mounted almost anywhere on the instrument panel, through a standard 3-in. hole. Ranger Aircraft Radio Division of Electronic Specialty Company, Los Angeles.

"Rainbow" Being Prepared for Global Transportation

A luxury air liner, the Republic Rainbow, is now under process of development. It will accommodate 40 passengers and a crew of 7, as well as provide ample space for the carrying of 1,600 lbs. of baggage plus 1,700 lbs. of cargo. The speed of this aircraft is expected to permit regular scheduled trips from New York to London or the European continent in 9 to $9\frac{1}{2}$ hours, New York to Mexico City in 5 hours, San Francisco to Honolulu in $6\frac{1}{2}$ hours, and from the United States West Coast to the Orient in 15 to 16 hours. The plane will feature complete dining facilities, a lounge, bar, plane-to-shore telephone, motion pictures, and other accessories for comfort and relaxation. Republic Aviation Corporation.



An artist's conception of the Republic 40-passenger Rainbow luxury air liner.

Room-Temperature Setting Adhesive

Announcement is made of a new room-temperature setting resorcinol adhesive that is stated to develop joint strength, moisture resistance, and durability usually associated only with hot-press phenolics. Known as Amberlite PR-115, this resin is suited to bonding applications where speed of cure, good adhesion to relatively impervious surfaces, good gap-filling qualities, and maximum durability are important requirements. Although originally developed for gluing wood to wood, the resin also shows good adhesion to laminates, rubber, and transparent plastics.

Amberlite PR-115 is supplied in solution form and requires the use of Catalyst P-117—a tan colored, dry powder—to effect cure. In spite of its fast curing properties, the prepared glue mix is reported to have working limits of approximately 3½ hours at 77°F. Glue spreads are at the rate of 50 to 70 lbs. per 1,000 sq.ft. of joint with a permissible open assembly period of 30 min. or a closed assembly period of 45 min. The method of double spreading in which one-half of the total glue spread is applied to each surface being joined is recommended by the maker, particularly in assembly work. Pressure applied when bonding should be sufficient to produce a thin glue line. Pressure of the order of 100 lbs. per sq.in. is most suitable for low-density woods, 150 lbs. per sq.in. for medium-density woods and 250 lbs. per sq.in. for the high-density species such as oak, maple, and birch.

The ability of Amberlite PR-115 to cure at moderate temperatures plus its fast cure at elevated temperatures indicates its use for radio-frequency gluing equipment.

This room-temperature glue is said to require less powder than many of the older resins, consequently evaporation of the water from the wood is minimized. There is also less danger of damage to the wood from overheating, crushing, checking or bursting of the fibers when heated rapidly by high frequency. Excessive temperature differentials which sometimes occur because of nonuniformity (hot spots) are almost completely eliminated with low temperature resins such as Amberlite PR-115.

This resin has been approved for use under Army Air Forces Specification 14124 (superseded June 1 by specification 14140) and Bureau of Aeronautics Specification G-33, Type I. It is recommended by the maker for use in conformance with Bureau of Ships Specification 52-G-12. Resinous Products & Chemical Company, Philadelphia.

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Jet Engine Lubricated by Air Spray

Lubrication of jet-propulsion engines is reported to be accomplished by means of a mistlike spray consisting of 95 per cent chilled compressed air and 5 per cent oil. The spray is directed on the ball bearings at either end of the engine, on which the single longitudinal axle revolves, the air cooling the metal and the oil protecting it from foreign matter and rust. After its lubrication function is performed, the spray is exhausted into the jet. It is stated that, in contrast to lubricants for the conventional internal-combustion aircraft engine, the jet-propulsion lubricant has only to cool and lubricate, yet must meet certain important requirements not made of other lubricants. Because it passes from extremely low temperatures (usually well below 0°F.) to temperatures of 800 to 1,000°F. in a matter of seconds, the jet lubricant must be extremely stable oil capable of flowing through the lines at these low temperatures and yet not breaking down when suddenly exposed to intense heat. Even more important, the jet lubricant must provide complete protection from rust. For this reason, a lubricant whose rust-inhibiting characteristics will be maintained under jet-engine conditions is still being sought. Shell Oil Company, Inc.

Small Air Hammer

A small, powerful pneumatic hammer, delivering some 13,000 blows per min. and operating on less than 2 cu.ft. of air at 80 to 100 lbs. per sq.in., has been released for general distribution. This tool was designed for special applications, where an exceptionally small tool with plenty of power and long lasting qualities were demanded.

Weighing less than 2 lbs., the hammer fits easily in the hand. A pistol-grip handle, made of a dimpled aluminum casting, gives the operator comfortable control of the rapid-firing power of the hammer. The valve control, in pistol-trigger position, adds to the ease of control.

Tools for the hammer are loaded in a quick-acting ball-and-channel locking chuck. A quarter-turn of the knurled nose of the chuck locks or releases any of the tools. The hammer has only one moving part, the piston striking member, which is precision-fitted in a finely ground cylinder. Travel of the hammer piston is approximately ⅜ in. and it normally operates at a rate of between 12,000 and 14,000 blows per min., depending upon the trigger regulation and the air pressure available.

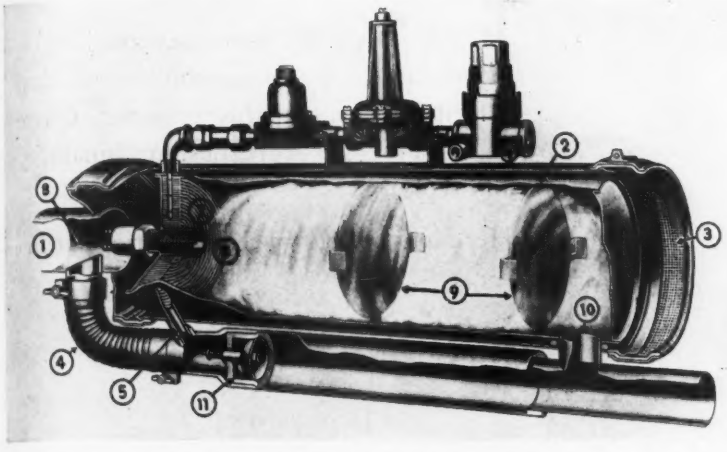
Uses so far discovered for the tool include all kinds of cold chiseling of metals, peening, welding-flash stripping, light scaling, light riveting, forming and finishing, routing of all kinds, paint and rust removal, star-drilling cement, caulking, template marking, loosening stubborn threaded fastenings by vibration, fender work, wood gouging in pattern making, and many special driving, cutting, and vibrating jobs in electric motor and small-machinery assembly. Superior Manufacturing Company, Cleveland.

Spark Ignition to Increase Applications for Aircraft Heaters

A newly developed high-altitude spark-ignition system for Janitrol aircraft heaters is announced. Positive and dependable ignition for combustion heaters at all altitudes is said to be provided by the new unit. Aircraft heaters, equipped with the new ignition coil-box assembly, can be ignited and will burn without fuel preheating, from sea level to 63,500 ft. at −67°F. This is thought to be the highest altitude at which a combustion-type aircraft heater has ever been spark-ignited. It is also approximately twice the altitude range at which previous spark-ignition systems on combustion heaters were considered reliable. Aircraft heaters equipped with the new heavy-duty ignition system are standard on current production Douglas C-54 airplanes.

Minimum field-service requirements are stated to be indicated by the number of service planes on which the new ignition system has operated over 1,000 hours without attention. No radio interference occurs as both ignition-box and high-tension spark plug leads used with the system are radio-noise shielded. Another feature of the system is the elimination of the fuel preheater previously required for low-temperature use. This simplifies installations and reduces consumption of battery current at low starting temperatures. One ignition unit assembly may be used for a single heater or for two heaters in a dual installation.

The new highly sensitive thermostats used to control airplane cabin temperatures frequently turn the heaters on and off a number of times per minute to effect close temperature control. Therefore this heater and ignition system, responsive to the thermostats by instant



Cutaway drawing of a 1,500 B.t.u. Janitrol aircraft heater of the type installed in the Waco cabin plane. Numbers indicate (1) ventilating air inlet; (2) alloy combustion tube; (3) heated air outlet; (4) connector; (5) air inlet nozzle; (6) fuel-air mixture; (7) vaporizer; (8) glow plug; (9) internal baffles; (10) exhaust opening; (11) spring-loaded valve.

lighting and delivery of heat, is credited with setting new standards of heating comfort and safety for airplanes. Surface Combustion Corporation, Toledo, Ohio.

Military Type Aircraft Heater Adopted for Cabin Plane

The Waco Aircraft Company has obtained C.A.A. approval to install a Janitrol aircraft heater in its five-passenger model VKS-7F. In the improved heating arrangement the Janitrol aircraft heater is installed under the rear seat. The heated air enters the cabin from an outlet under the rear seat and is forced forward across the floor of the cabin between the two front seats. An air scoop located on the top of the fuselage just aft of the cabin is connected to a small duct that supplies fresh air to the heater. When in flight the forward motion of the plane forces sufficient air through the scoop and ducts and over the heater to absorb the heat and evenly distribute it throughout the cabin. An adjustable control at the instrument panel permits a wide range of temperature selection.

It is reported that excellent ventilation is obtainable in warm weather by permitting fresh air to flow through the heating system with the heater turned off. The installation weight is negligible since the heater with its controls weighs only $7^1/_4$ lbs. Surface Combustion Corporation, Toledo, Ohio.

Two-Way Communication Unit

A low-voltage radio receiving and voice-transmitting communication unit is now in production. Useful for short-range voice communications, this "Transceiver," known as Model BRT-5, works directly from 24–28 volts d.c. without a dynamotor or vibrator power pack. It operates on a crystal-controlled fixed frequency within the four to seven megacycle band. The current drain is less than 2 amp., including the transmitter operation.

Model BRT-5 is designed for use in aviation, marine, and other fields. The aluminum construction of its cabinet, chassis, and mounting makes it extremely light in weight (10 lbs.) for its size ($6^1/_4$ in. high, $6^1/_2$ in. deep, by $12^3/_4$ in. long).

Two BRT-5 units will work reliably with each other over a range of 5 miles under average conditions. The receiver is reportedly capable of reception over much greater distances from high-powered transmission. Another feature of the Transceiver is the interphone switch which permits interphone facilities between two pairs of headphones when the transmitter is in operation. United Cinephone Corporation, Torrington, Conn.

"NC" Stencils

A new system of stencils for applying numbers on the wings and tail surfaces of an airplane is said to result in a better appearing job while taking but one-eighth the application time of former methods. These "NC" stencils are reported to conform to all requirements of the Civil Air Regulations relating to identification marks, as amended July 3, 1945. With the stencils, correct spacing between the figures is obtained automatically and no measuring of any kind need be done. By following instructions printed on each stencil, a pin-stripe edge may be made quickly and easily on the wing numbers. It is stated that the "connection links" that appear in the figures of conventional stencils are eliminated in this system. Adhesive used on the tail-surface stencils is identical with that used on regular aircraft masking tape. E. W. Wiggins Airways, Inc., Norwood, Mass.

Eye Shield

A new plastic eye shield, weighing less than 1 oz., has been developed for use in jobs such as spot welding, light grinding, and woodworking. Outstanding feature of the FeatherSpec is the one-piece plastic lens, gripped tightly in a new suspension-lock frame, but interchangeable or replaceable in 10 sec. A slight pull releases the lens from the grooved metal frame and makes it possible to substitute a green lens for a clear lens if the work involves glare. The new shield can be worn over special prescription lenses with complete comfort and gives added protection to those workers who wear glasses. Wilson Products, Inc., Reading Pa.

The Model BRT-5 United Cinephone short-range voice communications Transceiver.

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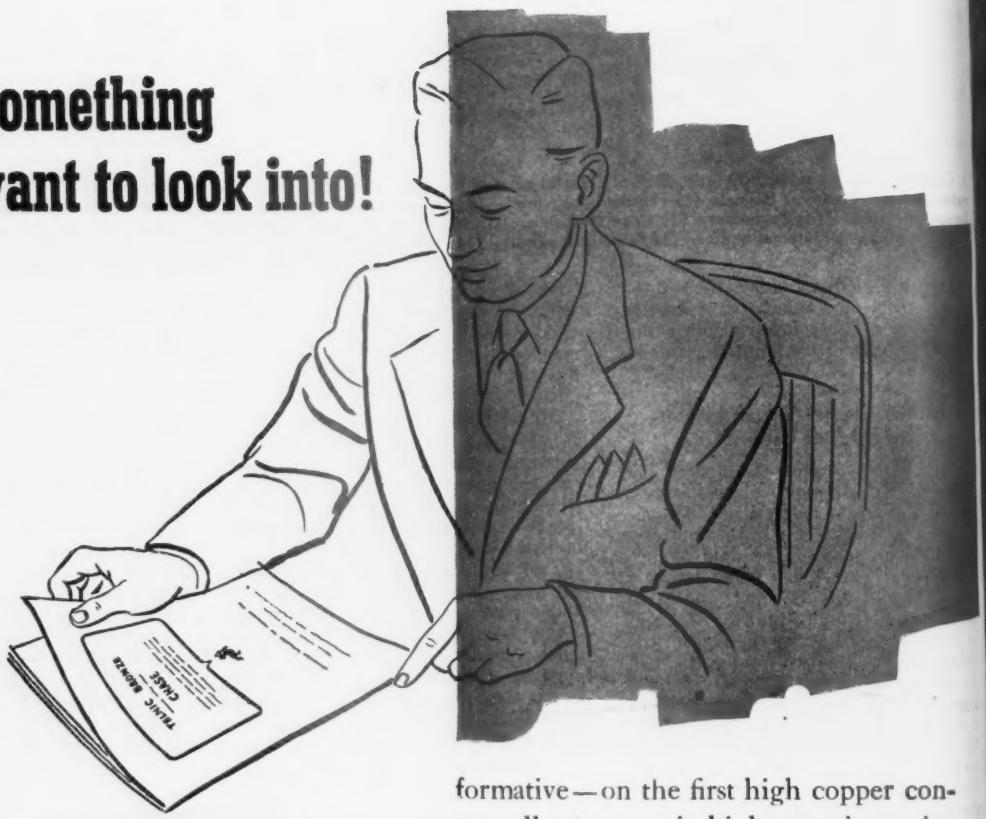

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